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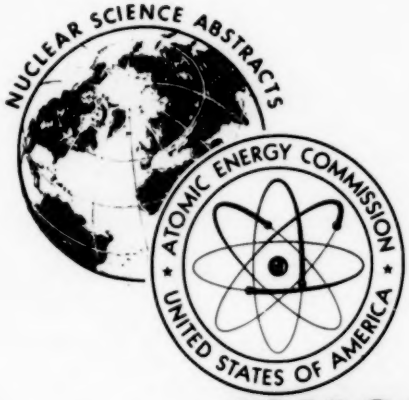

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Volume 19, Number 3, February 15, 1965

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstract 5020.

3820 (LF-16) THE DESIGN OF A CANINE INHALATION EXPOSURE APPARATUS INCORPORATING A WHOLE-BODY PLETHYSMOGRAPH. B. B. Boecker, F. L. Aquilar, and T. T. Mercer (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-2)-1013. 68p. Dep.; $3.00(cy), 2(mn) OTS.

A whole-body plethysmograph has been incorporated in an apparatus for exposing dogs individually to radioactive aerosols. This makes it possible to monitor the dog's respiratory pattern during the exposure without the use of any respiratory masks or valves. After three different transducer systems were evaluated for use with the plethysmograph, the flow rate transducer was chosen for several reasons including the fact that this system produces inspiratory and expiratory flow rate data as well as tidal volume and respiratory rate information. The aerosol is continuously produced and drawn past the dog's nose during the exposure period and provision has been made for quantification of the aerosol in terms of concentration and particle size distribution for each experiment. External contamination of the dog is minimal since only the nostril area is uncovered within the aerosol exposure chamber. Pertinent design and calibration features are discussed. (auth)

3821 (ORNL-P-655) DISTRIBUTION OF DOSE AND DOSE EQUIVALENT IN A CYLINDRICAL TISSUE PHANTOM FROM FISSION SOURCES OF NEUTRONS. Troyce D. Jones (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 74p. (CONF-803-3) Dep.(mn); $2.00(cy), 2(mn) OTS.

From International Symposium on the Dosimetry of Irradiation from External Sources, Paris, Nov. 1964.

A cylindrical phantom of radius 15 centimeters and height 60 centimeters is homogeneously composed of H, C, N, and O with the composition percentages present in standard man. Neutrons having the energy spectrum of fission sources are assumed to irradiate the phantom unilaterally and bilaterally. The phantom is divided into 150 volume elements, and the average dose is obtained in each such volume element for each exposure situation mentioned above. The percentage of the average dose in various ranges of LET are given for selected volume elements. This detailed distribution of dose with LET permits the estimation of dose equivalent in each volume element and also provides the fundamental data for study of the correlation of biological effectiveness with LET. Computer codes used in data analysis and the individual breakdown for the 5 fission neutron spectra treated are included. (C.H.)

3822 (ORNL-P-722) CURRENT TRENDS IN CANCER RESEARCH. Arthur C. Upton (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 19p. (CONF-754-4) Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Business Machines Medical Symposium, Poughkeepsie and Upton, N. Y., Oct. 1964.

Recent developments in cancer research are reviewed. Topics discussed include applications of molecular biology in studies of the nature of neoplastic transformation; autoradiographic studies of the kinetics of growth of neoplastic cells; mechanisms of action of carcinogens; cancer virology; immunological studies; cancer epidemiology; and the effective management of cancer patients. 52 references. (C.H.)

3823 (ORO-625) SEMI-ANNUAL PROGRESS REPORT, JANUARY 1–JUNE 30, 1964. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.). Contract AT(40-1)-Gen-242. 152p. Dep.; $5.00(cy); 3(mn) OTS.

Separate abstracts were prepared for ten sections of this report. A list is included of publications during the period covered. (C.H.)

For abstracts of individual sections see: 3835, 3836, 3837, 3891, 3892, 3893, 3894, 3895, 3896, and 4049.

3824 PENETRATION OF β PARTICLES THROUGH A SUBSTANCE. K. K. Aglintsev and V. P. Kasatkin. At. Energ. (USSR), 17: 217-19(Sept. 1964). (In Russian)

Experimental studies of the passage of β particles through filters of tissue-equivalent material ($Z_{eff} \approx 7$) are described. The spectra of the scattered β particles were investigated using a scintillation β spectrometer. Angular distributions of β particles emitted from ^{147}Pm, ^{185}W, ^{204}Tl, and ^{32}P sources were measured for varying filter thickness; results are compared with values calculated using a formula derived previously. The variation of total scattering, forward scattering, and backscattering with filter thickness is given for ^{32}P β particles. The theoretical dependence of the attenuation factor on the maximum β energy is compared with present and previous experimental results. (M.J.T.)

3825 POLYVINYL CHLORIDE PROTECTIVE FILMS IN AUTORADIOGRAPHY. W. Sawicki and Z. Darzynkiewicz. Folia Histochem. Cytochem., 1: 283-8(1963).

The methods of preparation and application of hydrophobic polyvinyl chloride (PVC) protective films are described. Films prepared by dropping PVC solution onto water were found to be the most satisfactory for autoradiographic purposes. The advantages and disadvantages of the application of such films are discussed. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3826 COMPARATIVE ANATOMY AND PULMONARY AIR-CLEANSING MECHANISMS IN MAN AND CERTAIN EXPERIMENTAL ANIMALS. S. Engel (Royal Coll. of Surgeons of England, London). Health Phys., 10: 967-71(Dec. 1964).

The comparative anatomy and the pulmonary air-cleansing mechanisms in man and certain experimental animals are discussed. It is shown that the lymphatic network represents the drainage system by which the lung rids itself, inter alia, of inhaled particles that cannot be expectorated. (P.C.H.)

3827 ALVEOLAR REACTIVITY FOLLOWING INHALATION OF PARTICLES. L. J. Casarett and P. S. Milley (Univ. of Rochester, N. Y.). Health Phys., 10: 1003-11 (Dec. 1964).

Clearance of inhaled insoluble particulate material from alveoli follows various pathways. Several modes of interaction between particles and cells of lung parenchyma are discussed briefly. A postulate is presented which suggests that alveolar epithelial cells are phagocytic and serve as at least one source of alveolar macrophages contributing to clearance of inhaled material. It is also suggested that alveolar epithelial cells, having phagocytized material, move either into alveolar spaces or into interstitial tissue depending, in part, on the relation of the cell to adjacent cellular components. A corollary hypothesis suggests that the rate of clearance of material deposited in alveoli is partially dependent on the phagocytic process and that this biological process is, in turn, dependent on the summation of influences of physical and chemical properties of the deposited particles. Brief allusion is made to some physiological and pathological implications of these hypotheses. (auth)

3828 ANIMAL HEALTH PROGRAMS, BIOLOGY DIVISION, OAK RIDGE NATIONAL LABORATORY. Robert C. Allen (Oak Ridge National Lab., Tenn.). Lab. Animal Care, 41: 260-3(Aug. 1964).

The animal health program in this Division was reorganized because of early deaths in irradiated mice from infection with Pseudomonas aeruginosa. Salmonellosis and other disease problems were also recognized and found to be interfering with various types of investigations. An intramural program was then initiated that is concerned with receiving, quarantining, and testing all newly arrived animals. Further objectives were the investigation of all outbreaks of disease, establishment of standards of sanitation necessary to eliminate and prevent the spread of contamination, and development of a program of preventative medicine in the stock and breeding animal colonies. A large proportion of mice used in the Division are obtained from outside vendors, so that the basic aim of this program has been to limit the introduction of diseases into the animal colonies by establishing rigid importation regulations pertaining to animals and animal products. Shipments of animals from approved vendors are received and quarantined for observation for 18 days, and fecal samples from pens are tested for both Salmonella and Pseudomonas species. Pens free of infection are moved to the animal facility in a specially designed sealed transport unit. Research programs are concerned with the role of microbial factors in radiation sickness, aging, neoplasia, and the development of immunity, function of the reticuloendothelial system, renewal of reticular, hemopoietic, intestinal, and epidermal cells. In such research, colonies of germ-free and specifically contaminated mice are being developed, for which comprehensive animal health programs and facilities are needed. The interrelations of the animal health programs at the Oak Ridge National Lab. with the various sources of animals, and how the programs are applied to these various sources, are diagramatically shown. The results and magnitude of the routine testing program, as well as the scope and work load in the diagnostic program, are outlined. These health programs are primarily designed to eliminate problems which are known to exist, but the research program may also elucidate other health factors. Other aspects of the research program are environmental influences on animals which may affect their normal growth, development, and aging, as well as their reaction to radiation and to other carcinogenic and mutagenic agents. (BBB)

3829 RADIOAKTIVNYE IZOTOPY V GIDROBIOLOGII I METODY SANITARNOI GIDROBIOLOGII. (Radioactive Isotopes in Hydrobiology and Methods of Sanitary Hydrobiology). V. I. Zhadin. Moscow–Leningrad, Izdatel'stvo "Nauka," 1964. 192p.

Applications of radioisotopes in hydrobiology and effects of radioactive substances on aquatic organisms and biological productivity of water basins are discussed. Methods in sanitary hydrobiology, microbiology, and hydrochemistry are reviewed. (R.V.J.)

3830 ZONAL CENTRIFUGE, A-XII (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn. and Oak Ridge National Lab., Tenn.). (CAPE-1168)

This package contains 3 drawings. For a listing of individual titles see the Engineering Materials List (TID-4100). A low-speed zonal centrifuge was developed. This A-XII centrifuge is an improved version of the A-IX Centrifuge. It is used to separate cells, subcellular particles, and other microscopic materials. The rotor volume of 1300 ml is divided into four equal sectors. Each sector is $^{9}/_{16}$ in. deep with a maximum radius of 7 in. and a minimum radius of 1.86 in. Rotor end caps are constructed of transparent lucite to permit visual observation. The maximum design speed of the rotor is 6,000 rpm. The A-XII core is a 45° cone section with a 3.72 in. OD and a 1.5 in. ID. It can be replaced by other cores to make the rotor suitable for a low volume application or for isopycnic banding. (F.S.)

Ecology

Refer also to abstract 4355.

3831 ORTHOPTERA OF THE NEVADA TEST SITE. Andrew H. Barnum. Brigham Young Univ. Sci. Bull., Biol. Ser., 4: No. 3, 1-134(Sept. 1964).

An ecological study was made of the Nevada Test Site from 1959 to 1964. Data are presented on Orthoptera. Methods used for collection and study are described, the environmental relations of Orthoptera are discussed, and specimens collected are classified. Analysis of data was facilitated by the use of an IBM punch card system and 650 computer. (C.H.)

3832 INFLUENCE OF SYSTEMATIC FERTILIZATION OF SOILS ON THE ACCUMULATION OF RADIOISOTOPES IN THE CROPS. I. V. Gulyakin. Izv. Timiryazev. Sel'skokhoz. Akad., No. 6, 138-50(1963). (In Russian)

Long systematic use of fertilizers affects the soil fixation of radioactive fission products and ^{60}Co as well as the accumulation of radioisotopes in crops. The systematic use of manure together with mineral fertilizers on limed soils increases the fixation of ^{90}Sr, ^{137}Cs, ^{144}Ce, and ^{60}Co and significantly decreases the accumulation of these substances in oats. Long application of phosphate fertilizers decreases the ^{90}Sr content of oats; and the addition of potassium to the soil decreases greatly the plant content of ^{137}Cs and the content of other radioisotopes to some extent. The amount of ^{60}Co in the plants is significantly increased by the use of nitrogen fertilizer, since long use of nitrogen fertilizers decreases the fixation of soil cobalt. (tr-auth)

3833 GAMMA SPECTROMETRY OF THE AIR AND PLANTS. E. Lanzola, E. Petrozzi, and A. M. Spina (Università, Rome). Minerva Nucl., 8: 269-73(Sept.-Oct. 1964). (In Italian)

Gamma spectrometry was used to investigate whether: the various fission products fall at different speeds; absorption through the leaves is considerable in some species of plants and not in others; the same species of plant, grown in different soils, absorbs radioactive elements in different amounts; and the activity concentrated in natural manures is appreciable. (auth)

3834 NATURAL AND ARTIFICIAL RADIOISOTOPES IN THE BIOSPHERE AND THE HUMAN ORGANISM. E. Oberhausen and H. Muth (Universität des Saarlandes, Hamburg). Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 25, 123-43(1963). (In German)

Radiation effects and distribution of natural and artificial

radioisotopes in the biosphere and in human organisms are reviewed. Fission product concentrations in soils, plants, food, and air are reported. (125 references). (M.C.G.)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 4412, 4435, and 4503.

3835 (ORO-625(p.64-9)) FISSION PRODUCT METABOLISM IN BEEF CATTLE, SHEEP AND SWINE. (Tennessee. Univ., Oak Ridge, UT-AEC Agricultural Research Lab.).

Progress is reported in studies of fission product metabolism in beef cattle, sheep, and swine. Emphasis was placed on nuclide interactions or similarities of metabolic pathways within the species investigated. Data are included on the effects of the chronic ingestion for 60 days of 20 mc daily of $^{144}Ce-^{144}Pr$ in sheep; the availability of ^{90}Sr from ^{90}Sr phytate and $^{90}SrCl$ in sheep; the metabolism of ^{89}Sr and ^{45}Ca in beef cows during pregnancy and in their progeny; the metabolism of ^{89}Sr and ^{45}Ca in young pigs 1, 3, or 7 days after whole-body irradiation; the influence of dietary Ca, Zn, and fat on the uptake of ^{65}Zn by blood cells in swine; and the secretion of ^{42}K, ^{134}Cs, and ^{65}Zn in the pancreatic juice of swine after intravenous injection. (C.H.)

3836 (ORO-625(p.70-85)) FISSION PRODUCT METABOLISM IN DAIRY CATTLE. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Progress is reported in studies of fission product metabolism in dairy cattle with emphasis on the pathway of fission product entry into milk and possible metabolic controls. Data are presented from studies on the effect of iodine compounds on the metabolism of Na ^{125}I in dairy cows; gastrointestinal absorption and excretion of ^{65}Zn and ^{144}Ce in dairy cattle; the effects of parathyroid hormone on the metabolism of ^{45}Ca, ^{89}Sr, and ^{32}P in cattle; the effects of lethal and sub-lethal doses of ^{60}Co γ radiation in lactating cows; and the effects of radiation on the rejection of skin grafts and blood changes in dizygotic twin cattle. (C.H.)

3837 (ORO-625(p.86-92)) FISSION PRODUCT METABOLISM IN POULTRY. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Progress is reported in studies of the metabolism of fission products in poultry. Data are included on the toxic effects of ^{131}I on chick embryos and young chickens; the effects of age and dietary stable Ca intake on the metabolism of ^{45}Ca, ^{89}Sr, and ^{32}P by chickens; and the effects of exogenous parathyroid extract on the metabolism of ^{75}Se by parathyroid tissue of chickens. (C.H.)

3838 INCORPORATION OF ^{32}P INTO NUCLEIC ACIDS AND PHOSPHOLIPIDS OF THE LIVERS OF TUMOUR-BEARING RATS. Miroslawa Weber, Annie Rossion, M. R. Riviere, R. Vendrely, and Colette Vendrely (Institut de Recherches Scientifiques sur le Cancer, Villejuif, France). Acta Biochim. Polon., 11: 153-7(1964).

Incorporation of ^{32}P-labeled phosphate into different liver fractions was studied in rats bearing the Guérin's T8 tumors at different stages of development. A marked increase of the incorporation into DNA, RNA, and the acid-soluble fraction was observed and can be explained by mitosis of the liver cells. The metabolism of the phospholipids was more complex; their total amount per cell decreased even at the time when the incorporation of ^{32}P increased. (auth)

3839 THE UPTAKE OF Fe^{59} BY OSSEOUS TISSUE ARISING IN VITRO. Wallace L. Past (Univ. of Louisville, Ky.). Am. J. Rathol., 45: 873-87(Dec. 1964).

Osseous tissue was grown in vitro by culturing entire limb buds from mouse fetuses in a chemically defined medium. The limb buds were at a pre-osseous stage of development prior to culture. A relatively strong uptake of ^{59}Fe by osseous tissue grown in this manner was demonstrated radioautographically. There was also a strong focal reaction for ^{59}Fe in the zone of hypertrophic cartilage cells, and a weaker reaction in maturing cartilage cells. All detectable uptake of ^{59}Fe was blocked by adding a potent chelating agent for iron, desferrioxamine methanesulfonate, to the culture medium just before introducing the ^{59}Fe. Despite the prevention of iron uptake, the developing osseous foci were not demonstrably different, by a variety of methods of histologic analysis, from those in control cultures. These findings indicated that it was not necessary for iron to accumulate in bone, or even for normal extracellular iron levels to exist, in order for bone formation to occur. It was of considerable interest that a spotty pattern of ^{59}Fe uptake observed in the zone of swollen cartilage cells seemed to correspond with similar patterns in the sections stained for phosphates and glycoprotein. It was therefore postulated that glycoprotein material attracted iron as well as calcium. (auth)

3840 RESTORATION OF MARROW FUNCTION AFTER LETHAL DOSES OF THIO-TEPA BY INFUSION OF ISOGENIC MARROW. E. D. Thomas, H. L. Lochte, Jr., Sh. Kasakura, and J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Bibliotheca Haematol., No. 19, 271-3(1964).

The use of fresh isogenic marrow in the mouse and dog in attempts to modify the mortality that follows the administration of thio-TEPA is described. The effect of infusions of isologous marrow on survival rates was studied in BDF_1 mice given intravenous injections of thio-TEPA. In the group treated with bone marrow there was a slight decrease in the mortality rate. The effect of infusions of bone marrow on mortality rates was also studied in mice given thio-TEPA intraperitoneally five times weekly for three to five weeks. In this group of mice, when mortality became appreciable, death generally occurred before the marrow was administered. Overall survival rates were approximately the same whether marrow was given or not. Dogs that were given infusions of autologous marrow showed prompt restoration of marrow function and survived. The data suggest that in the dog as in the mouse the usefulness of infusions of marrow falls off at high doses of thio-TEPA where intestinal complications become more severe. The results indicate that isogenic marrow in the mouse does not provide a useful protection against the lethal effect of thio-TEPA in the doses and dose schedule studied. Mortality from this drug involves organs other than bone marrow. In the dog, infusion of stored autologous marrow proved to be life-saving but only in a marrow range of thio-TEPA administration. It is inferred that assessment of the variables of dose, dose schedule, marrow toxicity, and tumor toxicity for each drug will be required for the effective use of stored autologous marrow in cancer chemotherapy in man. (BBB)

3841 METABOLIC STUDIES ON THE SUGARS OF NUCLEIC ACIDS. III. ^{14}C-LABELLING OF RIBOSE AND DEOXYRIBOSE IN RAT TISSUES IN VIVO. S. Itzhaki and Elizabeth D. Whittle (Cambridge Univ., Eng.). Biochim. Biophys. Acta, 91: 190-8(Oct. 16, 1964).

Carbon-14-labeled glucose was injected intravenously into rats and the incorporation of ^{14}C into the ribose and deoxyribose of nucleic acids was investigated. In the RNA of all tissues studied, namely, thymus, spleen, liver, and intestinal mucosa, the incorporation into the purine-bound ribose was higher than that into the pyrimidine-ribose. Further analysis showed that the specific activity of the ribose attached to cytosine was the lowest of the values for the four individual nucleotides; this was especially marked in the thymus. Similarly in the DNA, the specific activities of the deoxyribose moieties bound to the two purine bases were greater than the corresponding values of the pyrimidine-deoxyribose. These findings are in agreement with the results obtained previously from similar investigations in vitro. They are discussed here with reference to the formation of deoxyribotides from their respective ribose analogues. (auth)

3842 THE AUTODEGRADATION OF ^{32}P-LABELLED RIBOSOMES FROM ESCHERICHIA COLI. H. E. Wade, S. Lovett, and H. K. Robinson (Microbiological Research

Establishment, Porton, Wilts., Eng.). Biochem. J., 93: 121-8(Oct. 1964).

Exponentially growing cells of Escherichia coli were exposed to ^{32}P-orthophosphate to label 20 to 30% of the ribosomal RNA. The ribosomes were autodegraded into nucleoside 3'-phosphates (V-route) and nucleoside 5'-phosphates (M-route). The specific radioactivities of adenosine 3'-phosphate, uridine 3'-phosphate, and cytidine 3'-phosphate liberated by the V-route were similar at different times during the process and remained constant; the specific radioactivity of guanosine 3'-phosphate was significantly lower. The specific radioactivities of nucleoside 5'-phosphates liberated by the M-route process were dissimilar and diminished during the course of the process. This decrease was less pronounced with bacteria grown in a low-phosphate medium, suggesting a more radical incorporation into the ribosomal phosphate. The pattern of the incorporation of ^{32}P-orthophosphate into ribosomes in vitro suggested its confinement to terminal nucleotides. The results suggest the possibility that the instability of newly formed RNA attributed to messenger RNA may be due to the autodegradation of ribosomal RNA. (auth)

3843 EXPERIMENTAL COMPARISON OF THE RATES AND VOLUMES OF DISTRIBUTION OF UREA, CREATININE, N-ACETYL-4-AMINOPHENAZONE, AND TRITIATED WATER. R. E. Williams, A. H. Smith, G. A. Young, F. M. Parsons, and G. W. Reed (General Infirmary, Leeds, Eng.). Brit. J. Surg., 51: 544-9(July 1964).

The volumes of distribution and rates of equilibrium of urea, creatinine, N-acetyl-4-aminophenazone (NAAP), and tritiated water following intravenous administration in 23 bilaterally nephrectomized dogs were compared. The validity of the results was tested in 7 dogs by expanding the volume of distribution with a known volume of intravenous fluid; after re-equilibration the measured volume of redistribution was compared with the expanded volume of distribution. These compounds are defined as that volume of water in which the total body quantity is assumed to be homogeneously dispersed at a concentration equal to that in the plasma water. Following intravenous injection, tritiated water reached equilibrium of distribution in one hr, urea in 1.5 to 2 hr, NAAP in 3 hr, and creatinine in 4.5 to 6 hours. Urea and creatinine had volumes of distribution in the dog similar to those of NAAP and tritiated water. Small but significant differences were present between the mean volumes of distribution of creatinine and NAAP and between those of tritiated water and NAAP. Rapid expansion of the body water could be measured by alteration in the volumes of distribution of urea, NAAP, and tritiated water. An appendix on tritium-counting technique is provided. In the method used the plasma samples whose radioactivities were to be assessed were subjected to vacuum distillation yielding pure water. An aliquot of this could be added directly to the scintillator fluid. The preparation of samples preceded counting by at least 15 hr and the ampules were kept in darkness as completely as possible to minimize any effect of phosphorescence. It was noted that a complication in this method of tritium counting was that the observed response to a given activity of tritiated water depended on the particular quartz ampule used. However, by cross-calibrating the ampules with standard solutions it was possible to derive correction factors to bring them all to a comparable basis. By comparing the corrected counting rates of sample and standards, the activities of the sample were derived, and hence the radioactive concentration (μC/l) of the plasma water. (BBB)

3844 THE ROLE OF VARIOUS SECTIONS OF THE DIGESTIVE TRACT IN THE EXCRETION OF RADIOACTIVE CALCIUM. D. I. Bel'chenko (Kalinin Medical Inst., Academy of Sciences, USSR). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 891-3(Aug. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 68-70(Aug. 1963).

Excretion of ^{45}Ca with digestive fluids was studied in long-term experiments on dogs after intravenous injection of this substance. Investigations were carried out on experimental animals with isolated portions of the stomach, of the small and large intestine, as well as with exteriorized bile and pancreatic ducts. The greatest amount of ^{45}Ca was excreted with bile (up to 1% of the dose administered) and by the large intestine fistula (0.2 to 0.4% of that administered). The least amount of ^{45}Ca was excreted with the stomach juice (0.02% of the injected dose). (auth)

3845 THE INFLUENCE OF HORMONES OF THE POSTERIOR HYPOPHYSEAL LOBE ON THE STIMULATED THYROID GLAND. V. I. Gubskii (Khar'kov Medical Inst.). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 1029-32(Sept. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 107-11(Sept. 1963).

When an excess of pituitrin P was given to male rats, thyroid function was depressed although the hypophyseal thyrotropic hormone content remained normal. If 6-methylthiouracil and pituitrin P were given together the gland responded to the thiouracil in the normal way, although under these conditions there was no increase of hypophyseal thyrotropic function. It was concluded that pituitrin P must act directly on the thyroid parenchyma without the involvement of the thyrotropic hormone of the adenohypophysis. (auth)

3846 STUDIES ON INHIBITION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM. I. PREVENTION OF ABSORPTION FROM LIGATED INTESTINAL SEGMENTS. Stanley C. Skoryna, T. M. Paul, and Deirdre Waldron Edward (McGill Univ., Montreal). Can. Med. Assoc. J., 91: 285-8(Aug. 8, 1964).

Attempts were made to devise a method which would permit selective inhibition of absorption of radiostrontium from the gastrointestinal tract, while still permitting Ca to be available to the body. An in vivo assay method was used that would reflect most closely the physiologic conditions existing in the gastrointestinal tract, as well as other factors affecting ionic absorption. To evaluate interference of the intestinal absorption of the isotope, several naturally occurring macromolecular substances with ion-exchange properties were studied. A compound polymer of mannuronic and glucuronic acids known as alginic acid, which is found in various species of brown algae (Phaeophyceae), was found to be the most effective of the preparations tried. A method involving the use of ligated intestinal segments proved to be most useful in screening tests for efficacy of new compounds and dosage levels. This method employed the injection of ^{89}Sr and ^{45}Ca in the presence of an inert carrier into ligated intestinal segments in rats, and measurement of the amount of absorption by standard monitoring techniques. The pattern of absorption of both ions is very similar but the rate of absorption is different. Sodium alginate, injected simultaneously with radiostrontium effectively reduced the absorption of ^{89}Sr from all segments of the intestine by as much as 50 to 80% of the control values. No significant reduction in absorption of ^{45}Ca was observed in equivalent concentrations. The reduction of blood levels of ^{89}Sr and in bone uptake corresponded to the absorption pattern. The difference in the effect on Sr and Ca absorption may be due to differences in the binding capacity of Na alginate with the two metal ions under the conditions present in vivo. Sodium alginate was administered in quantities somewhat in excess of that required for two uronic acid residues to bind one atom of the divalent metal. It was not possible to increase the dosage of alginate beyond 1 mg/0.5 ml solution because of the high viscosity of the injected solutions. However, experiments in administration by means of orogastric tube showed that greater amounts of Na alginate are capable of depressing Ca absorption to some extent; however, this effect did not interfere with the nutritional balance of the animal. The amount of sodium alginate required to affect Sr absorption from intestinal segments is very small compared with the amount of citric acid or Versene used to suppress Ca absorption in similar experiments. (BBB)

3847 STUDIES ON INHIBITION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM. II. EFFECTS OF ADMINISTRATION OF SODIUM ALGINATE

BY OROGASTRIC INTUBATION AND FEEDING. T. M. Paul, Deirdre Waldron Edward, and Stanley C. Skoryna (McGill Univ., Montreal). Can. Med. Assoc. J., 91: 553-7(Sept. 5, 1964).

Results are reported on a method that enables selective suppression of absorption of ^{89}Sr from ingested food material, permitting Ca to remain available to the body. Studies were carried out by measuring blood levels and bone uptake of ^{89}Sr and ^{45}Ca at different time intervals after orogastric intubation of rats. The addition of sodium alginate, derived from brown marine algae, to the radioisotopes increased the overall physiologic discrimination against Sr by amount up to 60% after 24 hr. This discrimination was further increased by feeding sodium alginate mixed with standard diet. Addition of alginate to the food at the 10% level resulted in a decrease in bone uptake of ^{89}Sr to 58% of control value. Increasing the concentration of the binding agent to 20% and 30% resulted in a further decrease in bone uptake to 36% and 28%, respectively. Twenty per cent sodium alginate in the diet had no effect on the absorption of ^{45}Ca, but with 30%, the blood level and bone uptake of ^{45}Ca were reduced to 80%. The Observed Ratio (OR), ($^{89}Sr/^{45}Ca$ bone)/($^{89}Sr/^{45}Ca$ diet), calculated for control rats receiving 25 μC of ^{89}Sr and ^{45}Ca in their drinking water for one day was 0.26. This value is very close to that of 0.27 recorded in continuous feeding experiments. Sodium alginate feeding depressed the OR to 0.093; that is, increased the over-all discrimination against Sr by 70%. Determination of the limiting dosage in rats is restricted to the amounts which rats will consume. In the event of an inadvertent release of radiostrontium in the biosphere, humans probably could increase their intake of alginate at will, permitting a greater effectiveness of alginate than could be obtained here in rats. (BBB)

3848 RADIOACTIVE MONODISPERSE TEST AEROSOLS AND LUNG CLEARANCE STUDIES. Anders Kajland, Marie-Louise Edfors, Lars Friberg, and Bo Holma (Karolinski Institutet, Stockholm and National Inst. of Public Health, Stockholm). Health Phys., 10: 941-5(Dec. 1964).

Data are given from investigations into the production of radioactive test aerosols and studies of lung clearance in the rabbit. Lung clearance was measured using a specially developed profile scanning technique. This technique made it possible to follow the clearance rate from repeated measurements of the lung activity in a single animal. Furthermore, the animal could be re-exposed. Heterodisperse radioactive aerosols were used initially; more recently, monodisperse aerosols were used. Monodisperse radioactive aerosols in the particle range 1–10 μ were hitherto produced mainly by a modified LaMer method for lung clearance studies. Monodisperse radioactively tagged plastic aerosols were also produced by the spinning disk technique, and methods for iodinating (with ^{131}I) latex particles are in progress. (auth)

3849 BIOCHEMISTRY OF THE LUNG. J. M. Felts (Univ. of California, San Francisco). Health Phys., 10: 973-9(Dec. 1964).

The surface of the alveoli of the lung appears to be lined with a lipoprotein complex having a very low surface tension. The active component of this complex is probably a saturated lecithin molecule. The synthesis of phospholipids from both carbohydrate and lipid precursors was investigated. It was found that lung slices from rabbits readily oxidize plasma-free fatty acids and incorporate these into lecithin. Lung also readily metabolizes plasma triglycerides, acetate, and glucose. It is suggested that glucose availability plays a key role in promoting lipogenesis and directing the fate of the fatty acid molecule. Mechanisms are discussed that enable lung tissue to use plasma lipids for the synthesis of the phospholipid components of the surfactant. (auth)

3850 DEPOSITION OF MICROAEROSOLS IN HUMAN LUNG WITH SPECIAL REFERENCE TO THE ALVEOLAR SPACES. L. Dautrebande and W. Walkenhorst. Health Phys., 10: 981-93(Dec. 1964).

A method is described for estimating, in man, the degree of deposition of fine particles at various levels of the lungs. It avoids many of the artifacts observed when dealing with animals. Using the method described, the air collected from different levels of the lungs can be compared with the inspired air in order to determine, by particle counting and sizing, the deposition characteristics of the inhaled particles. It was observed that the deposition (in per cent of the number of particles per ml of inspired air) in the mixed expired air and in the last portion of the tidal volume was inversely proportional to the breathing frequency. Conversely, regardless of the breathing pattern, the per cent deposition was found to average more than 90% in the deep alveolar air where the air exchanges are governed by diffusion. It is only when voluntarily over-ventilating the alveolar spaces that the degree of deposition in the deep parts of the lungs can be reduced. Although, for every breathing rate, the end tidal air is characterized by a higher deposition rate than that of mixed expired air, it cannot be identified with deep alveolar air. When made exclusively of microsized particles, aerosols from hygroscopic salt solutions offer the same deposition curves as insoluble particles. The mean size of the particles collected in the successive portions of the expired air was observed to decrease regularly towards the deep alveolar air. The larger the original granulometric spectrum of the inhaled particles, the greater the difference in the mean size and in the size distribution curves between inspired air, mixed expired air, end tidal air, and alveolar air. However, the size distribution curves of the 0.5-μ maximum size particles did not exhibit appreciable changes from inspired air toward alveolar air, suggesting that the particles do not settle before reaching the deep alveolar spaces. The size most frequently observed for particles sampled from deep alveolar air lies between 0.05 and 0.4 μ; their maximum size has never been found to exceed 1 μ. 96 references are included. (P.C.H.)

3851 THE PROCESSES INVOLVED IN THE BIOLOGIC ASPECTS OF PULMONARY DEPOSITION, CLEARANCE, AND RETENTION OF INSOLUBLE AEROSOLS. Paul Gross (Industrial Hygiene Foundation, Pittsburgh). Health Phys., 10: 995-1002(Dec. 1964).

Pulmonary clearance by both physiologic and pathologic processes is discussed as an exquisitely effective mechanism for ridding the lungs of 98-99% of its inhaled foreign matter. The physiologic process is described as having two components, an upper respiratory mechanism and an alveolar mechanism. The manner of action and the factors influencing the efficiency of each component are discussed. The role of phagocytes as an aid in the clearance is placed in its proper perspective. (P.C.H.)

3852 INFLUENCE OF AEROSOL PROPERTIES UPON GROSS DISTRIBUTION AND EXCRETION. Robert G. Thomas (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Health Phys., 10: 1013-28(Dec. 1964).

Alteration of such aerosol properties as particle size and chemical composition have profound effects upon overall distribution and excretion patterns. Results of experimentation with several different compounds are used to exemplify this. These include studies with aerosols containing thorium, plutonium, niobium, uranium, and polonium. The relative merits of certain bioassay techniques following inhalation exposure are illustrated with experimental data. The influence that many of these variables may have upon various aspects of hazards evaluation is referred to throughout. (auth)

3853 A COMPARISON BETWEEN INHALED DUST AND THE DUST RECOVERED FROM HUMAN LUNGS. C. N. Davies (London School of Hygiene and Tropical Medicine). Health Phys., 10: 1029-34(Dec. 1964).

Experiments on the loss of dust particles during breathing indicate total deposition in the respiratory tract; subjection of the results to qualitative arguments may give information about alveolar deposition. Measurements of insoluble dust recovered post mortem from human lungs give the absolute retention of dust that was deposited in the alveoli and subsequently shifted, probably to a large extent, to the lymphatic vessels of the lungs. Experimental

results for total deposition and absolute retention are discussed in connection with the health risk due to inhaling insoluble particles, such as plutonium dioxide. (auth)

3854 THE DISTRIBUTION OF ^{239}Pu IN THE BODY FOLLOWING EXPOSURE BY INHALATION. Walter S. Snyder (Oak Ridge National Lab., Tenn.). Health Phys., 10: 1035-41(Dec. 1964). (ORNL-P-415)

Applying the standard lung model, a soluble aerosol deposited in the lung is absorbed into the blood, but some fraction of the more insoluble deposits remains in the lung for long periods of time. Conventionally, an elimination half time of 120 days is assumed for these insoluble deposits, and it is assumed further that ultimately most of this material is eliminated via the gastrointestinal tract. As a result, bone is not considered to be the critical organ for most insoluble aerosols of ^{239}Pu or other heavy metals. Recent work indicates that there may be a significant fraction of these insoluble deposits reaching the blood, and thus there is the possibility of a significant bone burden. At first glance, the available autopsy data on human exposure might seem to conflict with the above interpretation. However, a detailed data analysis of a human exposure record indicates that the above interpretation may be correct. Although the subject's skeleton showed a smaller concentration than did the liver, lung, or pulmonary lymph nodes, this does not exclude the skeleton as the critical organ. Applying the metabolic model, the lung would be expected to have a higher concentration than bone in the early years of exposure, although the latter would continue to increase and might become the limiting criterion governing continuous exposure for a working life. The evidence for and against this hypothesis is discussed in some detail. (auth)

3855 INTAKE OF RADIOSTRONTIUM IN AIRBORNE PARTICLES BY INFANTS. B. Kahn, R. Seltzer, P. Hallbach, and C. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati). Health Phys., 10: 1043-9(Dec. 1964).

The intake and retention of ^{89}Sr and ^{90}Sr from airborne particles were estimated for eight infants, ranging in age from 1 to 9 months, during the period April–July 1963. These infants are a part of a more extensive study to measure retention of ^{90}Sr, other radionuclides, and stable elements entering the body under normal environmental conditions by ingestion from food and water and inhalation from air. Levels of ^{89}Sr and ^{90}Sr were measured in airborne particles, water, and prepackaged baby foods. The amounts of these radionuclides inhaled as airborne particles and retained were computed from the concentration of ^{89}Sr and ^{90}Sr in airborne particles, and from the amounts of these radionuclides that were ingested and excreted. The intake of ^{90}Sr and ^{89}Sr with airborne particles was 0.6–1.7 and 3–14 pc/day, respectively. The volume of air inhaled daily was computed from this intake to be 11 ± 4 m^3. (auth)

3856 ^{95}Zr–^{95}Nb IN HUMAN LUNGS FROM FALLOUT. McDonald E. Wrenn, Rasmia Mowafy, and Gerard R. Laurer (New York Univ., New York). Health Phys., 10: 1051-8 (Dec. 1964).

The presence of easily measurable quantities of intermediate-lived fission products in ground level air during the first half of 1963 prompted an investigation of the distribution of gamma emitting nuclides in human lungs. Lungs from five cadavers were dissected, ashed and measured for ^{95}Zr–^{95}Nb, ^{137}Cs, and ^{40}K using a 4 × 4-in. NaI well crystal and a multichannel analyzer. Prior measurement of the cadavers in a whole-body counter, using an 8 × 4-in. NaI crystal positioned over their backs, permitted calibration of a low level in situ method of measuring ^{95}Zr–^{95}Nb in human lungs. Counting efficiencies ran from 3×10^{-2} to 6×10^{-2} counts/dis. in the full energy peak. The measured lung burdens ranged from 210 to 450 pC at the time of death and were comparable to the values expected from the ICRP model for insoluble materials. The distribution in the lobes was fairly uniform. (auth)

3857 RETENTION AND DISTRIBUTION OF ^{137}Cs AFTER ACCIDENTAL INHALATION. Charles E. Miller (Argonne National Lab., Ill.). Health Phys., 10: 1065-70 (Dec. 1964).

Two persons who accidently inhaled ^{137}Cs sulfate were measured for whole-body ^{137}Cs by the tilting-chair technique; the gross distribution of both ^{137}Cs and ^{40}K along the length of their bodies was determined by a simulated 7-crystal array. Whole-body measurements on the 9th, 52nd, 178th, and 285th days after exposure showed an average biological half time of inhaled ^{137}Cs of 73 days for one subject and 84 days for the other. For both subjects, despite steadily decreasing whole-body values, the pattern of cesium distribution remained constant, a fact that indicated absence of translocation of inhaled cesium within the body after the ninth day. (auth)

3858 DEPOSITION AND RETENTION OF ^{137}Cs IN THE RAT FOLLOWING INHALATION OF THE CHLORIDE AND THE NITRATE. R. Lie (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Health Phys., 10: 1071-6(Dec. 1964).

Several experiments were performed in which female rats were exposed to aerosols generated from solutions of cesium chloride varying in concentration from 0.005 to 50% or cesium nitrate at concentrations of 0.05 and 0.5 per cent. All solutions contained cesium-137 as a tracer. Some animals were sacrificed immediately following exposure for the purpose of studying whole-body deposition. Others were retained for whole-body counting and were sacrificed according to a schedule of 1, 2, 4, 8, etc., days after exposure. All animals were necrotomized and tissue samples were analyzed for cesium-137 content. Data from these studies show greater amounts of cesium deposited in the rat at the larger particle sizes. Retention kinetics, however, were not noticibly different following inhalation of different sized particles. Muscle concentrated cesium to an extent only slightly greater than that of other tissues. (auth)

3859 THE MEASUREMENT OF CILIARY CLEARANCE IN THE LUNGS OF RATS. A. A. Spritzer and J. A. Watson (Univ. of Pittsburgh). Health Phys., 10: 1093-7 (Dec. 1964).

A system is described for measurement of material cleared from rat lungs by the ciliary-mucous escalator. Placing a polyethylene tube in the animal's esophagus provides for the collection of all material swallowed; the caudad end of the tube empties into a collection bottle on the animal's flank. (auth)

3860 THE TURNOVER OF MERCURY IN RATS EXPOSED REPEATEDLY TO INHALATION OF VAPOR. Aser Rothstein and Alastair Hayes (Univ. of Rochester, N. Y.). Health Phys., 10: 1099-1113(Dec. 1964).

Groups of rats were allowed to inhale one of three levels of mercury vapor for 5 hr/day, 5 days/week for 8 weeks. The body burden, determined by whole-body counting, showed daily and weekly fluctuations related to the exposure regime in each experiment. For the first 3 weeks, the body burden increased, but thereafter a steady-state was attained in which the deposition during the exposure periods was balanced by the excretion plus radioactive decay. After exposure was terminated, the body burden decreased with an exponential decay (half time of 15 days). This data could be mimicked by a model based on ventilation rates, the deposition of inhaled mercury vapor, and on excretion patterns previously established by studies of single exposures to inhalation. (auth)

3861 THE EXCRETION OF VOLATILE MERCURY BY RATS INJECTED WITH MERCURIC SALTS. Thomas Clarkson and Aser Rothstein (Univ. of Rochester, N. Y.). Health Phys., 10: 1115-21(Dec. 1964).

When mercuric salts were injected into rats, volatile mercury was excreted, in part from the lungs and in part from the body surface. The amount of such excretion was small, averaging about 4% of the total excretion. In the first hours after injection, when the blood levels were high, excretion from the lungs was high, but thereafter, the excretion is about equally divided between the lungs and the body surface. The rate of volatilization fell more rapidly than the total body burden of mercury, parallel to the drop in levels of the metal in the blood and skin. (auth)

3862 ACUTE AND CHRONIC EFFECTS OF INHALED $^{144}CeO_2$ IN DOGS. B. O. Stuart, H. W. Casey, and W. J.

Bair (General Electric Co., Richland, Wash.). Health Phys., 10: 1203-9(Dec. 1964). (HW-SA-3597)

Effective half lives of 190–250 days were observed for ^{144}Ce–^{144}Pr inhaled as particles of the oxide (MMD 0.09–1.4 μ) by beagle dogs. Initial alveolar depositions of 0.05–2.2 mC caused decreased lymphocyte counts and slight neutrophil depression in all animals. One dog that deposited 2 mC in its lungs died 8 months post-exposure. Accumulated lung dose was 50–130 kiloRads. At death the lung, liver, and skeleton contained 22, 44, and 27% respectively of the total body burden. No clinical or biochemical changes were observed 21 months after exposure in dogs with an initial deposition of up to 0.9 mC. (auth)

3863 CHRONIC EFFECTS OF INHALED PLUTONIUM IN DOGS. J. F. Park, W. J. Clarke, and W. J. Bair (General Electric Co., Richland, Wash.). Health Phys., 10: 1211-17(Dec. 1964). (HW-SA-3670)

To study the long-term translocation and biological effects of inhaled plutonium, 40 beagle dogs were given single 10–30 min exposures to $^{239}PuO_2$ aerosols. Thus far eight dogs have died 28–48 months post-exposure. The body burdens at death ranged from 1–3 μC with about 50% of the body burden in the lungs, and as much as 50% in the bronchial and mediastinal lymph nodes. The liver contained 2–10%, and the skeleton, 1–4%. Cardiopulmonary insufficiency and lymphopenia were the primary clinical signs. Pathologic changes included fibrotic and metaplastic changes in the lungs, and fibrosis of the bronchial lymph nodes. In addition, pulmonary neoplasia was detected in four dogs. (auth)

3864 REMOVAL OF INHALED RADIOACTIVE YTTRIUM BY THE USE OF DIETHYLENETRIAMINE-PENTAACETIC ACID (DTPA). I. Schmidtke (Medizinische Universitätsklinik, Freiburg i. B.). Health Phys., 10: 1235-41(Dec. 1964).

Immediately after a single exposure to an $^{91}YCl_3$ aerosol, guinea-pigs inhaled a fog of a 25% DTPA solution for 30 min. In addition, 0.2 cm^3 of the same solution was applied by subcutaneous injection every day for 1 week. DTPA caused a rapid clearance of yttrium from the lungs and excretion from the body. The increase of the ^{91}Y elimination was mainly performed by the kidneys. Eight days after exposure the treated animals in the control group retained only 6.73% of the ^{91}Y content. The distribution pattern was not changed. (auth)

3865 EFFECT OF HEXAMETAPHOSPHATE AEROSOLS ON THE METABOLISM OF INHALED ^{91}Y CHLORIDE. F. Gensicke and H. W. Nitschke (State Central for Radiological Protection of the German Democratic Republic, Berlin; Institutes of Medicine and Biology, Berlin; and Inst. of Applied Isotope Research, Berlin). Health Phys., 10: 1243-9(Dec. 1964).

Twenty-four hours after a single inhalation exposure to radioyttrium (^{91}Y), mice were treated with Na-hexametaphosphate aerosols to study its influence on pulmonary absorption, translocation, and excretion of ^{91}Y. After nine treatments within 15 days following ^{91}Y exposure, the fractions of yttrium in lung and the organs were decreased 70% more than the controls. (auth)

3866 REVIEW OF THERAPEUTIC PROCEDURES FOR REMOVAL OF INHALED RADIOACTIVE MATERIALS. E. G. Tombropoulos (General Electric Co., Richland, Wash.). Health Phys., 10: 1251-7(Dec. 1964). (HW-SA-3621)

Chelating agents, when applicable, are the most effective means of removing radioactive particles from the lungs. The chemical form of the inhaled particles and their history before inhalation can alter the rate of clearance by these agents. Drugs that decrease mucus secretion or increase phagocytosis also merit further testing. Experiments with ^{144}Ce, ^{144}Pr, ^{239}Pu, and U supporting these conclusions are presented and discussed. (auth)

3867 INCORPORATION OF ^{14}C INTO VARIOUS SUBSTANCES IN LEAVES AT VARIOUS STAGES OF SOYBEAN ONTOGENESIS. I. F. Belikov and N. I. Chetverikova (Vladivostok Academy of Sciences, Siberian SSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser., Biol.-Med. Nauk, No. 4, 33-40(1964). (In Russian)

Studies were made of active carbon distribution in leaf protein at various stages of soybean ontogenesis. Two hours after incorporation the highest carbon activity was found in complex sugars and amino and organic acids. In blooming plants the highest activity was observed in simple sugars, with a maximum at the top of the plant. In ripe seed the maximum was in the complex sugars. Activity decreased in migrating fractions and slightly increased in immobile fractions 5 days after incorporation. (R.V.J.)

3868 EFFECTS OF SALICYLATE AND ITS NONCALORIGENIC CONGENERS ON THE THYROIDAL RELEASE OF ^{131}I IN PATIENTS WITH THYROTOXICOSIS. Kenneth A. Woeber, Russell M. Barakat, and Sidney H. Ingbar (Boston City Hospital and Harvard Medical School, Boston). J. Clin. Endocrinol. and Metab., 24: 1163-8(Nov. 1964).

In contrast to the findings in a recent report, large doses of salicylate did not consistently slow the thyroidal release of ^{131}I in patients with thyrotoxicosis. In 7 patients who received salicylate, and in 4 tests in which noncalorigenic congeners of salicylate (gentisate and gamma-resorcylate) were administered, slowing of thyroidal release of ^{131}I was observed in only two, and in both this change was very slight. In the remaining nine studies, salicylate or its congeners either did not change or appeared to increase thyroidal ^{131}I release rates. Since large therapeutic doses of ^{131}I were given to the patients in the previous study, it seems possible that the slowing of ^{131}I release observed was due to an inhibition by salicylate of radiation thyroiditis. In all the patients, a decrease in the PBI occurred during the administration of salicylate or its congeners. This decrease could be ascribed largely to the selective inhibition of thyroxine binding by prealbumin which was evident in all the patients during administration of these compounds. (auth)

3869 THYROID UPTAKE OF RADIOIODINE IN NORMAL SUBJECTS IN JAMAICA. I. J. L. Goldberg, R. Richards, H. McFarlane, and W. A. Harland (Univ. of West Indies, Kingston, Jamaica). J. Clin. Endocrinol. and Metab., 24: 1178-81(Nov. 1964).

A survey was made of 205 normal volunteers in Jamaica in whom thyroid radioiodine uptake, urinary stable iodine and radioiodine were measured. It was found that, at 24 hr after a tracer dose of ^{131}I, the mean neck uptake was only 13.8% of the administered dose. This is compared with results of about twice this value found in series done in temperate climates. The urinary excretions of ^{127}I and ^{131}I enabled the validity of the neck uptake measurements to be assessed. (auth)

3870 THE EFFECT OF PREDNISONE ON CALCIUM METABOLISM AND Ca^{47} KINETICS IN PATIENTS WITH MULTIPLE MYELOMA AND HYPERCALCEMIA. Carl J. Bentzel, Paul P. Carbone, and Leon Rosenberg (National Cancer Inst., Bethesda, Md.). J. Clin. Invest., 43: 2132-45 (Nov. 1964).

Five patients with multiple myeloma, four of whom were hypercalcemic, and two normocalcemic patients without bone disease or multiple myeloma were studied by combining metabolic balance and ^{47}Ca kinetic studies to determine the effect of prednisone on calcium metabolism. Prednisone therapy resulted in a reduction in serum calcium concentration in all hypercalcemic patients but was without effect in the patients with normal serum calcium concentrations. In patients with multiple myeloma, prednisone therapy was associated with a decrease in the degree of negative balance or no change in calcium balance. Miscible calcium pool size, bone formation rate, and bone resorption rate as determined by ^{47}Ca kinetic studies were elevated in the hypercalcemic myeloma patients and were reduced by prednisone therapy. Only small changes in calcium absorption and renal calcium transport were observed during prednisone therapy. No change in serum calcium binding during prednisone treatment was observed. It is, therefore, proposed that prednisone altered calcium exchange in and out of bone and favored the establishment of a new

equilibrium at reduced pool size, in part through an antitumor effect on malignant plasma cells. (auth)

3871 STUDY OF DISTRIBUTION AND MOVEMENT IN PERITONEAL CAVITY OF RADIOCOLLOIDS WITH DIFFERENT PHYSICAL AND CHEMICO-PHYSICAL PROPERTIES. B. Bellion, G. Buechi, S. Chiarle, and S. Sosi (Università, Turin and SORIN, Saluggia, Italy). Minerva Nucl., 8: 285-9(Sept.-Oct. 1964). (In Italian)

The biological behavior of different types of radiocolloids injected into the peritoneal cavity of healthy rabbits was investigated. The distribution of the colloids in the peritoneal cavity depends on the diameter of the particles, as does the proportion which passes into the blood stream. The chemico-physical properties of radiocolloids have a determining role in their migration, especially if the size of the particles is identical. (auth)

3872 INDUCTION OF IMMUNITY AND OF UNRESPONSIVENESS TO PARENTAL MARROW GRAFTS IN ADULT F_1 HYBRID MICE. Gustavo Cudkowicz (Oak Ridge National Lab., Tenn.) and J. H. Stimpfling. Nature, 204: 450-3(Oct. 31, 1964). (ORNL-P-92)

In contrast to the previous findings, pre-injection of resistant hybrid mice with parental spleen cells instead of parental marrow cells did not enhance the hybrid resistance and led, rather, to an opposite effect, that is, to the abrogation of hybrid resistance. This was accomplished when the hybrids were given multiple injections of spleen cells from their $H-2^b/H-2^b$ parents over a period of 4 weeks, whereas similar treatment with spleen cells of their parent, which carried an $H-2$ allele different from $H-2^b$, or with skin grafts of either parental strain, was ineffective. That injected spleen cells have a tendency in certain circumstances to yield specific unresponsiveness in adult allogeneic mice has been reported by several investigators. In this study, a similar condition was established in F_1 hybrid mice towards parental B10 and C3H·SW marrow grafts, provided that the exposure of the hybrids to the injected parental spleen cells was of sufficiently long duration. The extent of the hybrid's unresponsive state was estimated by comparing the splenic uptake of ^{131}IUdR in isogenic recipients and in pretreated hybrid recipients given test-grafts from a common pool of parental marrow cells. Injected spleen cells of either B10 or C3H·SW mice were capable of inducing unresponsiveness to B10 marrow grafts in C3H × B10 F_1 hybrids. Even though the abrogation of hybrid resistance induced by C3H·SW spleen cells was not as complete as that induced by B10 spleen cells, the spleen cell factor(s) responsible for induction of unresponsiveness appeared to be similar in the two unrelated homozygous $H-2^b$ strains, B10 and C3H·SW. It is suggested that induced enhancement and induced abrogation of hybrid resistance to marrow grafts from $H-2^b/H-2^b$ donors reflect acquired immunity and unresponsiveness, respectively, to cellular isoantigen(s) of the $H-2^b$ phenotype not present in $H-2^b$ heterozygous F_1 hybrids. (H.M.G.)

3873 ZINC-65 IN HUMAN HAIR. William H. Strain (Univ. of Rochester, N. Y.), Charles A. Lankau, Jr., and Walter J. Pories. Nature, 204: 490-1(Oct. 31, 1964).

Radiozinc determinations were made in hair from the nape of the neck of male Egyptian dwarfs suffering from zinc deficiency. Subjects were injected intravenously with 36 to 80 μC of ^{65}Zn chloride some months prior to sampling and were receiving zinc sulfate medication orally. Generally, there seemed to be no direct relation between radiozinc dose and hair levels. The radioactivity of the hair did not compare with the high values measured in rat hair. (H.M.G.)

3874 UPTAKE OF TANTALUM-182 BY FISH. Ryushi Ichikawa, Mikio Oguri, and Naoko Takada (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Suisan Gakkaishi, 29: 521-4(June 1963).

Tantalum-182 uptake by fish both from freshwater and from sea water was investigated. Tantalum-182 content in fishes was about 50 times the initial concentration in water on fresh weight basis. But the difference between higher and lower value of its content was approximately one and two orders of magnitude for freshwater and sea water adapted fish, respectively. The maximum permissible concentration of tantalum-182 in environmental water corresponding to the dose of ICRP recommendation was calculated as 2×10^{-6} μC/ml for the population at large when a higher level of concentration was used. (auth)

3875 INJURY TO FOLIAGE AND ITS EFFECT UPON THE LEACHING OF NUTRIENTS FROM ABOVE-GROUND PLANT PARTS. H. B. Tukey, Jr. and J. V. Morgan (Cornell Univ., Ithaca, N. Y.). Physiol. Plantarum, 16: 557-64 (1963).

The effect of injury to plants on the leaching of inorganic material was studied, the injuries investigated resulting from deficiencies of inorganic nutrients, carbohydrates, and water, from adverse temperatures, toxic materials, and mechanical damage. Young seedlings of bean (Phaseolus vulgaris), squash (Cucurbita pepo), and rooted cuttings of chrysanthemum (Chrysanthemum morifolium) were grown in aerated nutrient solution cultures, containing in some cases ^{45}Ca, ^{32}P, ^{86}Rb, ^{89}Sr, and ^{35}S. After two to three weeks, both radioactive and nonradioactive plants were injured and then were leached by either exposure to an atomized mist of distilled water, or immersion of individual leaves in aerated distilled water. Considerably more ^{45}Ca and ^{32}P were leached from plants deficient in those nutrients than from plants grown at adequate levels of both nutrients in the root medium. Leaves of deficient plants absorbed greater amounts of radioactivity per g dry wt. There was a greater loss of ^{86}Rb from the carbohydrate-starved plants than from the control plants, especially after 3 days in continuous darkness. Similar results were also obtained using ^{45}Ca instead of ^{86}Rb. Leaching of ^{45}Ca from the wilted primary leaves by immersion in aerated distilled water at 24°C was almost 8 times as great as from control plants. A considerably greater loss of ^{32}P occurred from heat-injured leaves (58% of the ^{32}P in the leaves) as compared with the leaves from control plants (0.2% of the ^{32}P in the leaves). Similar results were observed with ^{45}Ca, ^{86}Rb, ^{89}Sr, and ^{35}S. Losses of metabolites by leaching were also increased as compared with control plants, when foliage was injured by low temperatures, by applications of a toxic substance, and by mechanical means. Regardless of the cause of injury, injured foliage was more susceptible to leaching than was apparently healthy foliage. Leaching accentuates the harmful effect of injury to plants. (BBB)

3876 COMPARISON OF THE UPTAKE OF P^{32} AND K^{42} BY INTACT ALFALFA AND OAT ROOTS. Roger G. Lambert and A. J. Linck (Univ. of Minnesota, St. Paul). Plant Physiol., 39: 920-4(Nov. 1964).

The greater uptake of ^{32}P and ^{42}K by oats (Avena sativa L., var. Ajax) compared with alfalfa (Medicago sativa L., var. Ranger) when grown together in aerated solution culture might be explained partially by the greater total length and the larger number of oat root tips. When whole root systems of 7-day-old alfalfa and oat plants were immersed together in an aerated Hoagland solution containing ^{42}K for a 6-hour period in the light, 90% of the activity in the plant material was found in the oat plants. More ^{42}K was taken up from a wick by intact, 3-mm alfalfa root segments (1 cm back from the root tip) than from oat root segments of the same age plants, indicating that the greater effectiveness with which oats compete with alfalfa for potassium must be due primarily to the larger root system of the oat plant. The uptake of ^{32}P from an aerated Hoagland solution in the light for 6 hours by intact, whole root system of 15-day-old plants was 6 times greater in the oat plants than in the alfalfa plants. The uptake of ^{32}P from a wick by intact, 3-mm oat root segments (1 cm back from the root tip) was greater than that of similar segments of alfalfa roots. Four-day-old plants took up more phosphorus-32 than 15-day-old plants. These observations, together with the observation that excised oat root segments absorb more oxygen in respiration than comparable root segments of alfalfa, indicate that the greater effectiveness with which oats compete with alfalfa for phosphorus may not be due entirely to the greater size of the oat root system. (auth)

3877 PROTEIN-BOUND IODINE IN SERUM AND THYROIDAL UPTAKE OF ^{131}I: EFFECT OF IODOALPHIONIC, IOPANOIC, AND IOPHENOXIC ACIDS. Donald E. Ralston, Thomas T. Schattenberg, Charles A. Owen, Jr., and William M. McConahey (Mayo Clinic and Mayo Foundation, Rochester, Minn.). Postgrad. Med., 36: 141-8(Aug. 1964).

The effect of three organic iodinated compounds, (iodoalphionic acid, iopanoic acid, and iophenoxic acid), which are also used as radiographic contrast media, on the concentration of protein-bound iodine (PBI) in the serum and on the thyroidal ^{131}I uptake was studied. In most patients, the PBI values returned to normal within three months after administration of iodoalphionic acid and iopanoic acid, but occasional patients showed slight increases for longer periods. After administration of iophenoxic acid the PBI values increased exceptionally and then gradually decreased, but at 71 months they were still markedly elevated. The ^{131}I uptake returned to normal within two months after administration of iodoalphionic acid and iopanoic acid. In spite of prolonged retention of iophenoxic acid in the body, ^{131}I uptake returned to normal within 12 weeks in most patients. The return of ^{131}I uptake to normal within a few days was not necessarily diagnostic of hyperthyroidism. Caution is suggested in the interpretation of any increased PBI value or suppressed ^{131}I uptake months after the ingestion of these radiographic contrast media because of the occasional exception to the usual rate of return to normal values. The marked, uniform and long-lasting increase of PBI values after iophenoxic acid makes this parameter worthless for diagnostic purposes for at least 30 yr after the compound has been given and, perhaps, for the lifetime of the patient. It has been calculated that it would take 33 yr for the increased PBI value that results from the usual dose of iophenoxic acid to fall to 1 mcg/100 ml. Moreover, the children of mothers who had received iophenoxic acid before pregnancy have exhibited increased PBI values similar to those of their mothers, and there could even be transfer to the third generation. (BBB)

3878 EFFECT OF D_2O ON UPTAKE IN YEAST. R. T. O'Brien (General Electric Co., Richland, Wash.). Proc. Soc. Exptl. Biol. Med., 117: 555-8(Nov. 1964). (HW-SA-3583)

Deuterium inhibited uptake of glucose, potassium, and phosphate. Potassium uptake inhibition was probably due to the depressed rate of glucose catabolism in D_2O. Glucose and phosphate uptake inhibition was due to direct isotope effects on the transport processes. Uptake and the effects of D_2O on uptake were the same for deuterio-glucose as for ordinary glucose. Results of experiments on the effects of D_2O on sorbose and glucose transport indicated that these sugars enter the cell by different mechanisms. It was concluded that the immediate effects of D_2O in depressing the rates of growth and glucose catabolism were due to inhibition of glucose and phosphate uptake. (auth)

3879 THE ROLE OF CATECHOL AMINES IN THE MECHANISM OF PITUITRIN; CORONARY INSUFFICIENCY IN HEALTHY AND IRRADIATED RABBITS. V. M. Volodin and E. N. Petrovnina. Radiobiologiya, 4: 703-7(1964). (In Russian)

A sharp increase in the pituitrin coronary deficiency was observed on the 5th to 7th day after irradiation in rabbits given a whole-body x-ray dose of 800 R. Extra ventricle sistoles and heart murmurs were frequently observed. In a number of cases the coronary deficiency was so intense as to lead to the death of the animal. The introduction of pituitrin led to a larger increase than usual in the content of noradrenaline in the blood and heart muscle. Adrenalin, which was observed in the myocardium of irradiated animals, could not be observed after the injection of pituitrin. In addition, oxidation products were detected by a fluorescence analysis in the myocardium of 4 out of 6 rabbits after pituitrin injection. These oxidation products could not be found in the control, irradiated rabbits. The sensitivity to pituitrin becomes normal again 8 to 9 months after the irradiation. The appearance of catechol amines in the myocardium and the increase in amine oxidation by pituitrin injection may be an important mechanism in the development of pituitrin coronary deficiency. (TTT)

3880 COMPARISON OF TWO ISOTOPE TECHNIQUES FOR ASSESSMENT OF THE BLOOD VOLUME. P. Delwaide and J. Leclercq (Université, Liège). Rev. Med. Liège, 19: 201-9(1964).

A comparison was made of two methods for measuring the blood volume, one by measurement of the erythrocyte volume after labeling with ^{51}Cr, the other by measuring the plasma volume with iodinated albumin. The study was made on 20 patients with serious surgical disorders. A rather general discordance was found between the results of the two techniques; with iodinated albumin the values were considerably higher. Examination of the activity curves as a function of time suggested the intervention of several factors. It appears that in serious cases there is a space of rapid distribution of the serum albumin largely overlapping the plasma compartment. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3881 DECORPORATION OF RADIOACTIVE SUBSTANCES. H. Kriegel (Heiligenberg Institut, Ger.). Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 25, 171-7(1963). (In German)

Studies on intensifying the elimination of radioisotopes from the body are reviewed. Uses of complex-forming substances, soluble ion exchanges, isotopic dilution, and other measures are described. (41 references). (M.C.G.)

3882 REPLACEMENT RATES FOR HUMAN TISSUE FROM ATMOSPHERIC RADIOCARBON. W. F. Libby, Rainer Berger, J. F. Mead, G. V. Alexander, and J. F. Ross (Univ. of California, Los Angeles). Science, 146: 1170-2(Nov. 27, 1964).

^{14}C, derived from the testing of thermonuclear weapons in the atmosphere of the Northern Hemisphere during 1961–62, was found in human tissues including the brain in amounts that reflect the atmospheric concentration of ^{14}C as of several months earlier. In collagen of cartilage, the rate of uptake of ^{14}C was much slower than in other tissues; essentially no radioactive carbon was found in the collagen of 70-year-old adults that were exposed to the comparatively high concentrations of ^{14}C in the atmosphere during the years 1954 to 1964. Individuals from the Southern Hemisphere showed little increase in the ^{14}C content of their tissues. Tests with individuals traveling to the Northern Hemisphere from the Southern will allow closer scrutiny of the tissue replacement rates. (auth)

3883 PHARMACOLOGY AND TOXICOLOGY OF PRASEODYMIUM AND NEODYMIUM CHLORIDES. Thomas J. Haley, N. Komesu, M. Efros, L. Koste, and H. C. Upham (Univ. of California, Los Angeles). Toxicol. Appl. Pharmacol., 6: 614-20(Sept. 1964). (TID-19953)

Intraperitoneal and oral LD_{50} values were obtained with male CF1 mice. Chronic toxic effects of the two elements were studied by including 0.01, 0.1, and 1.0% of each compound in the diet and feeding it over a period of 90 days to CRW rats. The intraperitoneal $LD_{50/7}$ for Pr and Nd chlorides were both 600 mg/kg and by the oral route 4500 and 5250 mg/kg, respectively. The symptoms of acute toxicity were ataxia, writhing, labored respiration, walking on toes with back arched, and sedation. Some deaths occurred in 24 hr, and the peak was reached in both cases in 48 hr. Thus, both chemicals exhibited a delayed acute toxicity with symptoms similar to those seen with other members of the rare earth series. Chronic oral ingestion of both Pr and Nd chlorides for 12 weeks at three dosage levels produced no changes in the hemogram and no evidence of histopathologic damage to the internal organs. On all systems studied, these chemicals exhibited a depressant action and produced death by cardiovascular collapse coupled with respiratory paralysis. Instillation into the eye resulted, with both, in transient conjunctival ulceration. Skin damage with scar formation occurred upon application to abraded, but not to unabraded, skin. Intradermal injection of either chemical produced nodules containing foreign body giant cells and crystals. Both Pr and Nd in a dosage

range of 10 to 40 mg produced an increasing depression of tonus and contractility of the rabbit ileum. Both elements counteracted the spasmogenic effects of acetylcholine and nicotine. Neither chemical produced any observable effects in the cat within the dosage range of 1 to 10 mg/kg. Both chemicals produced transient hypotension with decreases of 15 to 70 mm Hg and decreases in peripheral blood flow when the dose was 20 mg/kg. At 40 mg/kg, Pr was lethal to 8 of 10 animals, whereas Nd killed 6 of 10. With the latter, atropinization increased sensitivity. All animals receiving a dose of 60 mg/kg died in cardiovascular collapse coupled with respiratory paralysis. The terminal electrocardiographic changes produced by both chemicals are described. (BBB)

3884 RASPREDELEINIE: BIOLOGICHESKOE DEISTVIE, USKORENIE VYVEDENIYA RADIOAKTIVNYKH IZOTOPOV. (SBORNIK RABOT). (Distribution, Biological Effects, and Rapid Excretion of Radioactive Isotopes). Yu. I. Moskalev, ed. Moscow, Meditsina, 1964. 375p.

Forty-five articles are included on the distribution of ^{137}Cs, ^{45}Ca, ^{90}Sr, ^{144}Ce, ^{239}Pu, ^{95}Nb, ^{113}Sn, ^{124}Sb, ^{127}Te, ^{99}Mo, ^{32}P, ThX, and ThB, and mixed U fission products in various animals. Kinetics of uptake and excretion of single and chronic doses in organisms of horned animals and dogs are analyzed, and the characteristics of transmission of radioisotopes to progenies of various animals are described. Studies of biological effects of various nuclides (^{137}Cs, ^{90}Sr, ^{3}H, ^{147}Pm, ^{95}Nb, ^{91}Y, and ^{239}Pu) in cows, sheep, and dogs showed that single treatments are more conducive to carcinomas, leukopoietic, and thrombocytopoietic depression, and life shortening and that such effects do not depend on the path of incorporation. The high carcinogenic activity of ^{239}Pu was traced in dogs for 2 years after intravenous, treatment with 0.2 μC/kg in the form of Pu nitrate. Uptake and excretions of uranium fission products, ^{3}H, ^{90}Sr, ^{45}Ca, ^{239}Pu, and ^{144}Ce in the intestinal tract were studied, and it is shown that diethylenetriaminepentaacetic acid (DTPA) has the most effective complexing properties. It was also observed that vegetable oils increase deposition of ^{90}Sr in the skeletons of rats while a low protein diet reduced (12 to 32%) ^{90}Sr and ^{45}Ca deposition. Magnesium chloride and oxide slow ^{90}Sr absorption by the intestinal tract, however, the content of calcium in the diet has no influence of ^{90}Sr absorption. Therapy of radiation injuries is also discussed. (R.V.J.)

3885 THE ROLE OF PLANTS AND ANIMALS IN THE CYCLING OF RADIONUCLIDES IN THE MARINE ENVIRONMENT. T. R. Rice (Bureau of Commercial Fisheries, Beaufort, N. C.). 24p. (CONF-642-4).

From Health Physics Society, Cincinnati, June 1964.

Plants and animals have a capacity, which varies from species to species, for concentrating specific radionuclides. The level to which an isotope is concentrated by any organism can vary with season, geographical location, and other factors not completely understood at this time. Plants and animals play an important role in the cycling of radionuclides in the sea not only while living, through metabolism, but also after death, through the process of decomposition. The availability of radionuclides to marine organisms is dependent to a large extent upon the physical state in which the isotopes occur in seawater. Both particulate and dissolved radionuclides can enter into the biogeochemical cycles of the marine environment. These materials can remain in solution or in suspension, precipitate and settle on the bottom, or be taken up by plants and animals. Immediately upon introduction of radioactive materials into the water, certain factors interact to dilute and disperse these materials, while simultaneously other factors tend to concentrate the radioactivity. Radioactive materials upon introduction into the marine environment may be cycled through the following three components: water, sediment, and biota. Each radionuclide takes a characteristic route and has its own rate of movement from component to component prior to coming to rest in a reservoir, one of the three components of the marine environment. Plants and animals to be of any significance in the cycling of radionuclides in the marine environment must accumulate the radionuclide, retain it, be eaten by another organism, and be digestible. Organisms can obtain radioactivity by absorption, adsorption, and ingestion. Conversely, radionuclides may be lost by excretion and decomposition. Sediments may accumulate radionuclides through the physical processes of exchange and adsorption. Water acts as the principal medium of transport between the biota and sediments. Seafood organisms that contain radioactivity are a potential health hazard to man. The extent of this hazard depends upon the amount of radioactivity concentrated in the edible tissues of the organisms. Fish and shellfish are among the marine animals of greatest concern from the standpoint of public health. It is important to determine the accumulation of the different radionuclides by the various marine organisms in order to identify those that can serve as biological indicators. Biological indicators are defined as those organisms concentrating relatively large amounts of specific radionuclides making it possible to detect the presence of minute amounts of these isotopes in the environment through an analysis of the organisms. (auth)

Radiation Effects

Refer also to abstract 5125.

3886 (AD-601083) POLAROGRAPHIC CATALYTIC WAVES AND REACTIVITY OF SULFHYDRYL GROUPS IN BOVINE PLASMA ALBUMIN SOLUTIONS BEFORE AND AFTER ULTRAVIOLET IRRADIATION IN THE ABSENCE AND PRESENCE OF RADIATION PROTECTIVE AGENTS. VISCOSITY AND OPTICAL ROTATION. Annual Progress Report, June 1963–May 1964. Walter Stricks (Marquette Univ., Milwaukee). Contract DA-49-193-MD-2146. 83p. $2.25 (OTS).

Polarographic studies of several antiradiation drugs were performed and it was found that, although the mercaptans behave alike, a remarkable difference exists in the polarography of their disulfides. The catalytic mercaptan waves were studied. Under favorable experimental conditions these waves can be applied to the quantitative determination of traces of mercaptans, disulfides, and thiosulfates, and in the study of the changes which occur in albumin upon ultraviolet (UV) irradiation in the absence and presence of radiation protective agents. The experiments show that antiradiation drugs can preclude denaturation of albumin through UV irradiation. The effects of UV irradiation prior to investigating the changes in albumin upon exposure to ionizing irradiation were also studied since the reactions occurring during UV irradiation probably precede those which occur upon exposure to high energy irradiation. A quantitative study of structural changes in albumin is the determination of the reactivity of sulfhydryl and disulfide groups in relation to physical changes, such as viscosity and optical rotation of the protein upon exposure to radiation in the presence and absence of radiation protective agents. In this way it is possible to obtain a better insight into the mechanism of the radiation effects on protein and of the action of radiation protective agents in biological systems. (auth)

3887 (CONF-642-8) AN IMPROVED METHOD OF DOSE CALCULATION FROM AIRBORNE FISSION PRODUCTS. Norman A. Harris, Paul Kenfield, William Lahs, and William Sayer (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [196?]. Contract AT-11-1-GEN-18. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

From Health Physics Society, Cincinnati, June 1964.

The CURIE-DOSE program is a combination of two basic computer programs employed in tandem. The first, CURIE, calculates the fission product buildup and decay as a function of the reactor operating time and decay time. The second program, DOSE, uses the fission product data obtained from CURIE to calculate the dose to various body organs due to inhalation of fission products released to the atmosphere from a reactor. The CURIE-DOSE code is written in Fortran for use on the IBM 709, 7090, or 7094 computer with 32K memory storage. Applications using the

latest available sources of fission product data are described. (C.H.)

3888 (EUR-1829.f) COMPARAISON DES EFFETS DE DIFFERENTS AGENTS MUTAGÈNES PAR L'ÉTUDE DE LA MUTAGÈNESE DE QUELQUES PLANTES-TYPES. (Deuxieme Annee d'Etude). (Comparison of the Effects of Various Mutagenic Substances by Studying the Mutagenesis of Some Typical Plants. (Second Year of Study)). P. Dommergues (France. Institut National de la Recherche Agronomique, Paris) and J. Gillot (European Atomic Energy Community). 1964. 17p. Dep.(mn).

Simultaneous studies were made on plants with vegetative multiplication and on plants with sexual reproduction. The mutagenic effects of γ radiation on pears, apples, roses, and carnations were determined, and the results are tabulated. The mutagenic effects of methyl ethyl sulfonate and γ radiation on various varieties of wheat were compared. (J.S.R.)

3889 (NYO-2181-2) EPIDEMIOLOGICAL FOLLOW-UP OF THE NEW JERSEY RADIUM CASES. I. REPORT OF THE MEDICAL STUDY GROUP. II. RESUMES OF FINDINGS FROM INDIVIDUAL CASE STUDIES. Progress Report to April 1964. Alvin A. Florin, Hyman W. Fisher, Carye-Belle Henle, and Robert Bonda (New Jersey. State Dept. of Health. Radium Research Project, West Orange). Contract AT(30-1)-2181. 62p. Dep.; $3.00(cy), 3(mn) OTS.

Selected preliminary data on new radium cases studied, as well as data on cases seen at follow-up examinations by the Project medical staff since the last progress report (NYO-10604), are presented. Ten additional resumés of findings from individual case studies are included, bringing the total of such published resumés to 160. Five previously unreported malignancies which have been encountered are listed. Five radium cases died and three post mortem examinations were performed. Diagnoses from death certificates or post mortem examinations are presented. Death certificates were studied for 212 persons known or believed to have been radium workers. A total of 70 cases among the 212 had malignancies mentioned on their death certificates. Eleven individuals showed changes on roentgenograms in the interval between initial and follow-up examinations. A single case has developed multiple myeloma since the initial examination. Bone specimens from 15 cases were studied roentgenographically to date. Preliminary comparisons of roentgenographic and gross and histology examinations of bone specimens are presented. Results of scoring roentgenographs by the MIT and Argonne National Laboratory system, and by a proposed New Jersey Radium Research Project system, are presented, in addition to a detailed critique of the problems included in devising a suitable scoring system. Osteosarcoma, necrosis of articular aspect of bone, and the presence of numerous punched-out radiolucencies in bone appear on preliminary examination to be associated in the reported cases with body burdens of radium-226 in excess of 0.0247 μc. Few cases showed unusual dental changes between initial and follow-up examinations. Alveolar bone healed satisfactorily after dental procedures, irrespective of body burden. Pathology studies performed on case specimens are reported. (auth)

3890 (NYO-3103-1) [PROGRESS REPORT ON RADIORESISTANCE OF SPORES, FINAL, JUNE 1, 1963–AUGUST 15, 1964]. Stephen Zamenhof (Columbia Univ., New York). Contract AT(30-1)-3103. 8p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

Strain differences were demonstrated in the radioresistance of spores of Bacillus subtilis to x radiation and ultraviolet radiation. Differences in heat-resistance of two strains paralleled the differences in radioresistance. (C.H.)

3891 (ORO-625(p.1-27)) CLINICAL MEDICINE IN RADIATION STUDIES. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Data are presented from studies on the clinical aspects of early and late radiation injuries in domestic animals. The early effects studies are related to problems of survival of animals used for food following a nuclear attack as well as basic problems of acute radiation injury. The objective of the late effects studies is to ascertain indications of delayed damage to animals surviving irradiation. Results are reported from studies of the effects of doses of 100, 250, 1000, and 2,000 R ^{60}Co whole-body γ radiation on the central nervous system of sheep; the effects of 1000 R ^{60}Co γ radiation or 600 rads of fast neutrons on the central nervous system and blood picture of burros; the pathological effects of unilateral and bilateral exposure to an average dose of 500 to 675 rads mixed neutron and γ radiation in swine; the survival of adult steers exposed to 100 R and 50 R per day of ^{60}Co γ radiation; the status of burros surviving exposure to mixed neutron and γ radiation in 1957, exposure to γ radiation in 1951, or exposure to neutrons in 1959; the status of swine surviving neutron-γ irradiation from an atomic detonation; the status of cattle surviving an $LD_{50/30}$ γ exposure in 1959; and the status of one cow surviving from a group exposed to radioactive fallout from the first atomic test at Alamogordo, New Mexico, in 1954. Data are included from a comparative study of the toxic effects of ^{90}Sr and ^{226}Ra in sheep, and a study of feed utilization associated with the late effects of external whole-body irradiation. (C.H.)

3892 (ORO-625(p.28-37)) PHYSIOLOGY OF REPRODUCTION. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Progress is reported in studies on the effects of radiation on the reproductive system in domestic animals, rats and rabbits. Data are included on the effects of chronic irradiation on sperm production and testis histology in bulls; the effects of irradiation on the fertility of cows; the effects of prenatal irradiation and maternal malnutrition on morphological development of lambs; the effects of chronic irradiation on the gonads of swine; the effects of radiation on the fertility of female burros; the effects of irradiation on sperm production of rabbits; and the effects of prepuberal irradiation on the reproductive potential of male rats. Techniques for the in vivo culture of leukocytes from cattle and the induction of anesthesia in domestic animals by electric current were investigated. (C.H.)

3893 (ORO-625(p.38-55)) RADIATION PATHOLOGY. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Eighty cadavers from five species of domestic animals were examined histologically. Emphasis was placed on an analysis of death patterns of irradiated animals. Findings are presented for cattle, burros, sheep, swine, and rabbits. (C.H.)

3894 (ORO-625(p.56-63)) PHYSIOLOGICAL EFFECTS OF RADIATION. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Progress is reported in studies on the effects of radiation on physiological processes in domestic animals. Results are reported from studies of the effects of injections of urine from whole-body irradiated human patients and swine in rats; the effects of blood ultrafiltrate from irradiated and normal sheep on bone marrow and leukocytes in tissue culture, and tumor incidence in female rats. (C.H.)

3895 (ORO-625(p.103-8)) BIOCHEMISTRY OF FISSION PRODUCT ELEMENTS. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Results are reported from studies on the biochemistry of fission product elements in mammals. Data are included on detoxification mechanisms in whole-body irradiated rats; the excretion of glucuronides by irradiated and starved rats dosed with naphthalene or antranilic acid; and the effects of whole-body irradiation and starvation on the synthesis of antranilic glucuronide by the duodenum in rats. (C.H.)

3896 (ORO-625(p.109-29)) PLANT GENETICS. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Results are reported from studies on the heritable effects of γ radiation on embryos, buds, and pollen of plants and environmental factors that modify these effects. Data

are included on the effects of γ radiation on the vegetative buds of Coleus blumei, disbudded carnations; and hybrid cotton embryos; embryonic features that affect seed radiosensitivity; mass and selection breeding methods; the genetic effects of radiation in seeds of 4 cotton varieties; heritable changes resulting from the irradiation of soybean seeds; the effects of moisture and radiation intensity on the radiosensitivity of seeds of bluebonnet, Oryza sativa; and the dosimetry of a ^{135}Cs γ source. (C.H.)

3897 (UCRL-11668) PRIMARY QUANTUM CONVERSION IN PHOTOSYNTHESIS. Melvin Calvin, R. H. Ruby, and Irwin D. Kuntz, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1964. Contract W-7405-eng-48. 58p. (CONF-611-2). Dep.(mn); $3.00(cy), 2(mn) OTS.

From 4th International Photobiology Congress, Oxford, July 1964.

The primary quantum conversion act in photosynthesis is defined as that event during which electronic excitation is converted into chemical species which are separable and which may be isolable. As yet no unambiguous assignment for such an event has been made. There appear to be two major alternative approaches. The first is that a molecular event occurs leading directly to a chemical species from the excited molecule. While a great deal of work has been done over the years toward this end, no assignment of this sort has yet been achieved and work from this point of view continues. The second approach, involving the transfer of an electron from one molecule to another as the primary event, gives rise to a one-electron oxidant and a one-electron reductant in two different sites physically separated from each other as the primary chemical storage products. It is this latter point of view which is now being most actively sustained and it is the evidence for this viewpoint which is examined in the present paper. While a good many different kinds of evidence have been brought to bear, we will discuss only two, namely, that derived from the optical changes induced in the photosynthetic apparatus by actinic light and the magnetic changes induced by the actinic light. An examination of the variety of these changes and the kinetics of their formation and disappearance, as well as the dependence of these kinetics on physical and chemical environmental variables, leads to the supposition that the sequence of events is: absorption of light; migration of the exciton to the point of electron transfer; electron transfer producing a trapped electron and mobile hole, or, conversely, a trapped hole and mobile electron; followed by migration of the mobile particle to another point in the photosynthetic apparatus to a corresponding trap of opposite type. The reactions succeeding these events, such as the formation of adenosine triphosphate and the reduction of pyridine nucleotide, are dark enzymatic chemical reactions, some of which have been separately achieved. (auth)

3898 (FTD-TT-64-1077(p.234-46)) REACTIVITY STATE OF ANIMAL ORGANISM AFTER SUBJECTION TO CERTAIN SPACE-FLIGHT FACTORS. V. V. Antipov, V. I. Davydov, E. F. Panchenkova, P. P. Saksonov, and G. A. Chernov. Translated from Kosmich. Issled., 2: 797-804 (1964)

Data are given on the changes in the reactivity of animals to physical exertion following subjection to g-forces, the combined action of acceleration and x-irradiation, and irradiation by 120-Mev protons. The shifts detected indicate a persistent change in the stability to physical load following subjection to acceleration, ionizing radiation, and combinations of these factors. The change in the tolerance of centrifuged animals to physical load correlates with ceruloplasmin shifts in the blood serum. (auth)

3899 UNCOUPLING AGENT OF OXIDATIVE PHOSPHORYLATION FROM ASCITIC FLUID OF TUMOR BEARING MICE AFTER X-IRRADIATION. Kozo Inaba (Okayama Univ., Japan). Acta Med. Okayama, 18: 33-43 (Feb. 1964).

The relationship between the composition of the lipid fractions obtained from the ascitic fluid of Ehrlich ascites tumor bearing mice and its uncoupling activity after whole body irradiation (1,000 R) was investigated. Oxidative phosphorylation of Ehrlich ascites tumor cells was loosely uncoupled with the addition of ascitic lipid fraction extracted from tumor bearing mice. The uncoupling activity of the lipid fraction on the oxidative phosphorylation of the tumor cells increased after whole body irradiation. Ascitic lipid fraction, especially acetone soluble fraction, accelerated mitochondrial swelling, and the swelling action was increased remarkably by the whole body irradiation. No significant changes were observed in the proportion of acetone soluble fraction to acetone insoluble fraction in the ascitic lipid after x irradiation, and the proportion of both the fractions was approximately 9:1, respectively. Main compositions of total and non-esterified fatty acids in the ascitic fluid obtained from the control and x irradiated groups were palmitic, stearic, oleic, linoleic and palmitoleic acids, and the proportions of unsaturated acids, especially oleic and linoleic acids in both fatty acid fractions were greater in the x irradiated group. Remarkable increment of unsaturated fatty acid, especially linoleic acid, was also observed in the total fatty acids of the tumor cells separated from the x irradiated group. It can be concluded that an uncoupling agent extracted from ascitic fluid of the x irradiated group was a mixture of long-chain fatty acids, especially oleic and linoleic acids. It was also discussed that uncoupling oxidative phosphorylation in liver mitochondria after whole body irradiation may be caused by a similar mechanism to that in the tumor cells. (auth)

3900 EFFECT OF IONIZING RADIATION (Co^{60}) ON THE BRAIN DURING AND AFTER ARTIFICIAL INTRACRANIAL HYPERTENSION. H. Cardauns and O. Wilcke (Universität, Cologne). Acta Neurochir., 11: 676-85(1964).

In 28 cases the effect of ionizing radiation on the rabbit brain was investigated during and after experimentally induced raised intracranial pressure. The radiation source employed was ^{60}Co pearls of 6 mm diameter and of about 8 mC activity. Radiation applied during the acute phase of raised intracranial pressure evoked morphological changes corresponding to those described in the literature as early changes: inflammatory infiltration and a hyaline thickening of the meninges and of the vessel walls. The brain substance itself reacted only with a proliferation of the subpial glia and degenerative changes in the ganglion cells. However, if the radiation was applied after the phase of raised intracranial pressure, so-called late changes with necrosis, gitter cells and proliferation of astrocytes occurred. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3901 STERILITY DUE TO RADIOACTIVE PHOSPHORUS IN MICE. E. A. D. Holmberg, C. Dosne de Pasqualini, E. Arini, A. Pavlovsky, and S. L. Rabasa (Instituto de Investigaciones Hematologicas, Academia Nacional de Medicina, Buenos Aires and Instituto de Investigaciones Medicas, Rosario, Santa Fe, Argentina). Acta Radiol. Therapy, Phys., Biol. (N. S.), 2: 337-44(Oct. 1964).

The uptake of ^{32}P was studied in normal, pregnant, and progesterone-treated mice. Pregnancy affords some protection against the sterilizing effect of radiophosphorus and progesterone lends a significant protection against the isotope. It is suggested that pregnancy may act through the production of progesterone or through a hormonal state that makes the ovary more resistant to radiophosphorus. (auth)

3902 CHANGES IN ELECTROLYTE BALANCE IN THE GASTROINTESTINAL SYNDROME. Z. Zseboek and Gy. Petrányi, Jr. (Medical Radiology Research Inst., Hungarian Academy of Science, Budapest). Acta Radiol. Therapy, Phys., Biol. (N. S.), 2: 377-83(Oct. 1964).

The changes in electrolyte balance immediately preceding gastrointestinal death were studied with Na-isotope and inulin methods in rats irradiated with 1200 R x radiation. The terminal stage of the gastrointestinal radiation syndrome was found to be characterized by passage of sodium from the extracellular space into the damaged gastrointestinal tract. (auth)

3903 PURE CULTURE FERMENTATION OF BRINED CUCUMBERS. J. L. Etchells, R. N. Costilow, T. E. Anderson, and T. A. Bell (North Carolina Agricultural Ex-

periment Station, Raleigh and Michigan State Univ., East Lansing). Appl. Microbiol., 12: 523-35(Nov. 1964).

The relative abilities of Pediococcus cerevisiae, Lactobacillus plantarum, L. brevis, and several other species of lactic acid bacteria to grow and produce acid in brined cucumbers were evaluated in pure culture fermentations. Such fermentations were made possible by the use of two techniques, gamma radiation (0.83 to 1.00 Mrad) and hot-water blanching (66 to 80 C for 5 min), designed first to rid the cucumbers of naturally occurring, interfering, and competitive microbial groups prior to brining, followed by inoculation with the desired lactic acid bacteria. Of the nine species tested, strains of the three common to cucumber fermentations, P. cerevisiae, L. plantarum, and L. brevis, grew to the highest populations, and produced the highest levels of brine acidity and the lowest pH values in fermentations at 5.4 to 5.6% NaCl by weight; also, their sequence of active development in fermentations, with the use of a three-species mixture for inoculation, was in the species order just named. This sequence of occurrence was similar to that estimated by others for natural fermentations. The rates of growth and acid production in fermentations with a mixture of P. cerevisiae, L. plantarum, and L. brevis increased as the incubation temperature was increased from 21 to 27 to 32 C; however, the maximal populations and acidities attained were essentially the same for fermentations at each temperature. Further, these same three species were found to be the most salt tolerant of those tested; their upper limit for appreciable growth and measurable acid production was about 8% salt, whereas thermophilic species such as L. thermophilus, L. lactis, L. helveticus, L. fermenti, and L. delbrueckii exhibited a much lower salt tolerance, ranging from about 2.5 to 4.0%. However, certain strains of L. delbrueckii grew very rapidly in cucumbers brined at 2.5 to 3.0% salt, and produced sufficient acid in about 30 hr at 48 C to reduce the brine pH from above 7.0 to below 4.0. An inexpensive, pure culture fermentor which was suitable for gamma radiation, resistant to salt and acid, and which permitted repeated aseptic sampling of the fermenting brine, is illustrated and the specifications are given. (auth)

3904 EVOLUTION OF SOME EXPERIMENTAL VIRUS INFECTIONS UNDER THE ACTION OF RADIATIONS EMITTED BY RADIOACTIVE PHOSPHORUS AND IODINE. N. Cajal and O. Burducea. Arch. Union Med. Balkan., 1: 675-80(1963).

Rats inoculated with various viruses received 90 min after the infection an injection of ^{32}P (in solution) or of ^{131}I (in solution). The individual dose of radioactive substance was 25 μC, administered intraperitoneally. The mortality rate, the incubation and survival period, the pathologic lesions and, in case of influenza virus, the HA content of lungs were followed. Worsening of the experimental disease was noticed in influenza infection, polyomyelitis with type 11 virus, murine hepatitis (MHV_2, MHV_4), rabies with street virus and with fixed virus and herpes. Adult irradiated rats received a paralytic lethal disease after inoculation of Coxsackie A_2 virus. Serological and biochemical investigations demonstrated that under the action of β and γ radiations emitted by ^{131}I, the amount of antibody HAI diminishes, as well as the concentration of serum properdin. The hypothesis is put forward that the exceptional frequency of viruses in old age (cancer being in its turn a virus disease) is a consequence of the rise of radioactivity threshold in nature, following the nuclear tests. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3905 FACTORS REGULATING ANTIBODY PRODUCTION BY SPLEEN CELLS CULTURED IN VIVO. J. F. Albright, T. Makinodan, and Elmos E. Capalbo (Oak Ridge National Lab., Tenn.). Bibliotheca Haematol., No. 19, 301-8(1964).

In vivo culture of antibody-synthesizing cells in the isologous, heavily irradiated animal was used for analyzing factors that control antibody formation. The method consists of transferring the cells of spleen, or other lymphoid tissue, from nonimmunized or previously immunized donors into isologous recipient mice. The latter are rendered incapable of responding to the test antigen by x irradiating them with 800 R. Any antibody appearing in the serum of the recipients has thus been produced by the transferred cells. This technique reveals a linear relation between $\log_2$ antibody titer and number of transferred spleen cells. The slope of the line, however, depends upon the time after antigen stimulation at which antibody titer is measured. The slope is one when titers are compared four to six days after antigen stimulation but less than one at other times. The results indicated that in the nonimmunized animal there is a finite number of cells which can respond to a given test antigen. The estimate that there is one potentially competent cell per test antigen in $\sim 10^7$ spleen cells, coupled with the previous estimate that there are $\sim 10^9$ spleen-like cells in a 25-g mouse, leads to the figure of $\sim 10^2$ potentially competent cells per test antigen in the normal, young adult mouse. Since previous immunization increases the number of cells which can respond to a given antigen by a factor of 100, a primed animal will have $\sim 10^4$ potentially competent cells. The amount of antibody which an animal will produce will be directly related to the number of potentially competent cells that are stimulated by antigen. This number, in turn, will depend upon antigen dosage, the route of antigen administration, and, presumably, the degree to which a potentially competent cell is stimulated, i.e., full efficiency of antibody production by a cell may require more than one collision with antigen. A cell that has been properly stimulated will undergo rapid proliferation at a rate which largely determines the rate of increase of titratable antibody. The stimulated cell will, according to an earlier hypothesis, also undergo suicidal differentiation leading to a terminal cell that retains neither the capacity for further proliferation nor the ability to produce antibody. (BBB)

3906 CHANGES IN THIOL CONTENT OF THE HAMSTER CHEEK POUCH AFTER X-IRRADIATION AND SOME SPECULATIONS ON THE RELATIONSHIP BETWEEN PHOSPHOLIPIDS AND PROTEIN THIOL GROUPS. Dwight B. McNair Scott, A. B. Reiskin, and Anna M. Pakoskey (Univ. of Pennsylvania, Philadelphia). Biochem. J., 93: 1c-3c(Oct. 1964).

Results are reported from measurements of the thiol content of hamster cheek pouches after exposure of the pouches to 5000 R x radiation while the rest of the body was shielded. It was concluded that the changes in thiol content of the irradiated pouches were not the primary reaction but the result of a humoral reaction. (C.H.)

3907 DEGRADATION OF DESOXYRIBONUCLEOPROTEINS FROM NORMAL ANIMALS AND AFTER WHOLE-BODY γ-RAY IRRADIATION IN AN ACID MEDIUM. N. V. Ermolaeva. Biochemistry (USSR) (English Transl.), 28: 333-40(May-June 1963). Translated from Biokhimiya, 28: 407-17(May-June 1963).

Desoxyribonucleoprotein degradation with DNA liberation was studied during incubation of rabbit appendix tissue homogenates. Fractionation of degradation products yielded free, protein-bound DNA and acid-soluble DNA breakdown products. Incubation of homogenates in acid media lead to rapid accumulation of free soluble DNA at 0°. The optimal pH range for DNP degradation at 0° is 5.4 to 5.6 at an ionic strength of 0.005 to 0.030. The rate of the process rose with increases in temperature but at the same time was accompanied by significant DNA binding by proteins. At optimal values of pH and ionic strength the DNP degradation rate at 0° in isolated nuclei was lowered due to the absence of the cytoplasmic part of homogenate. At the same time the ratio of DNA liberation and binding at 37° was changed. An enzymatic nature of these processes is suggested by their dependence on pH and ionic strength of the medium, on the temperature, presence of Mg and Ca ions, and iodoacetate as well as by the effect of cytoplasmic part of the homogenate on the velocity of the processes studied. No change in DNP degradation rate was noted upon incubation of appendix tissue homogenates within either 5 min. or 1 hr. after whole-body irradiation of rabbits (1000 R). The DNP degradation ratio fell 3 hr after irradiation. (auth)

3908 VISCOSITY OF THE DEOXYRIBONUCLEIC ACID OF IRRADIATED BACTERIOPHAGE T2. Yu. P.

Vinetskii. Biochemistry (USSR) (English Transl.), 28: 380-6(May-June 1963). Translated from Biokhimiya, 28: 467-74(May-June 1963).

A study was made of the viscosity of the DNA of T2 phage exposed, under conditions of direct and indirect action of the radiation, to UV light, ^{60}Co γ radiation, and soft x rays (50 Kv), and also of the ability of the inactivated particles to inject DNA. The depolymerization effect of ionizing radiation on phage DNA was much greater than was that of UV radiation. Radiation of high ionizing density (x rays) caused more profound degradation of DNA than did γ radiation. Breakdown of DNA to fragments of $[\eta] = 100-120$ dl/g proceeded at a rapid rate as the dose of radiation received by the phage particles rose to 3 lethal hits; further depolymerization took place at a lower rate with increase in dose to 10 to 14 hits. The sensitivity to x rays of the reproductive function of T2 phage exceeded that of the apparatus for injection of DNA at cell walls by a factor of 1.2, and to γ rays by a factor of 2.5. The ability to inject DNA was correlated with its molecular weight in the phage head, whence it is concluded that the injection mechanism can only go into action when the degree of polymerization of the DNA is above a certain limiting value. (auth)

3909 EXISTENCE OF "RESCUE" CONCERNING THE TRANSFORMING ACTIVITY OF A DEOXYRIBONUCLEIC ACID AFTER X-IRRADIATION. Nicole Rebeyrotte (Université, Paris). Biochim. Biophys. Acta, 91: 281-8 (Oct. 16, 1964).

The damages produced by x rays do not prevent either denaturation or renaturation of DNA. It was possible to prepare hybrid molecules with an x-ray-inactivated DNA carrying a genetic marker (streptomycin resistance) and a wild-type DNA. The rescue of transforming activity of the irradiated DNA, in respect of the irradiation dose and of the concentration ratio of the two DNA's at the time of the renaturation was examined. (auth)

3910 CONTROL OF INSECTS BY STERILIZATION BY GAMMA RADIATION. Kamta P. Katiyar. Bol. Junta Control Energia At. (Peru), 9: No. 48, 25-8(Jan.-Mar. 1964). (In Spanish)

The control of insects by gamma sterilization of the males is briefly described, and the advantages of this method are tabulated. The principal studies now in progress on its practical utilization are summarized. (J.S.R.)

3911 APPLICATIONS OF NUCLEAR ENERGY IN ENTOMOLOGY. Bol. Junta Control Energia At. (Peru), 9: No. 48, 103-6(Jan.-Mar. 1964). (In Spanish)

Four possible projects for the eradication of insects using male sterilization by gamma radiation are described. The insects to be eradicated are the Mediterranean fruit fly, the olive fly, locusts, and the tsetse fly. The cost of a coordinated investigation to determine the feasibility of the projects is estimated. (J.S.R.)

3912 ON TRANSPLANTATION OF "RADIATION" TUMORS OF THE MAMMARY GLANDS IN RATS. V. I. Ponomar'kov. Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 908-10(Aug. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 85-8(Aug. 1963).

Adenocarcinoma of the mammary glands, occurring after the administration of ^{93}Nb to rats, are transplantable to other rats. With further transplantations there occurs a gradual rise in the rate of the transplant growth and of its take. In morphological respect this phenomenon is characterized by progressive anaplasia of the tumor tissue. After the 5th generation the transplant became capable of metastasization to many internal organs. A rise in the area of the mammary gland transplant in repeated successive transplantations lies at the basis of this phenomenon. (auth)

3913 QUANTITATIVE CHARACTERISTICS OF OOCYTES IN THE OVARIES OF WHITE RATS SUFFERING FROM ACUTE RADIATION SICKNESS. V. Ya. Karmysheva (Pavlov Ryazan Medical Inst., Academy of Sciences, USSR). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 919-22(Aug. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 97-101(Aug. 1963).

A study was made of the content of persistent and atresic primordial growing and cavitary follicles in the ovaries of sexually mature and immature albino rats after general x irradiation at a dose of 600 R. During the first days after the irradiation the main mass of the oocytes was ablated, and the drop of the number of primordial follicles was pronounced. No restoration of the sex cells occurred in the irradiated rats. However, up to 6 months after the action of ionizing radiation some primordial growing and cavitary follicles had a normal structure. The ovaries of immature rats were more radiosensitive. It was established that changes in the gonad volume did not reflect the dynamics of the sex cell content at various periods of acute radiation sickness. (auth)

3914 DIRECT REACTIONS OF THE NERVOUS SYSTEM TO IONIZING RADIATION. A. B. Tsypin. Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 962-4 (Sept. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 34-7(Sept. 1963).

Acute experiments were carried out on sexually mature chinchilla rabbits to study the electrical activity of the depressor nerve (40 animals), the vagus and sympathetic nerves (in 10 animals each), and the intestinal branch of the splanchnic nerve (3 animals) during the period of exposure to ^{60}Co γ rays. From 10 to 20 min. before the beginning of the experiment the sympathetic, vagus, or depressor nerve was dissected in the neck of an unanesthetized rabbit. The approach to the intestinal nerve and the recording of its electrical activity were undertaken in rabbits anesthetized with ether and chloroform. Platinum wire electrodes 0.3 to 0.5 mm. thick were applied to the nerve. The action potentials of the nerves were amplified by means of a four-stage ac amplifier and recorded on a Siemens three-loop oscillograph. The background action potentials were recorded usually for 5 to 10 min., after which the rabbits were totally irradiated with ^{60}Co γ rays with total dose of 150 to 300 R. The electrical activity of the nerves was recorded throughout the period of irradiation. Control investigations on 10 rabbits showed that keeping the animals in the experimental conditions, without irradiation, for 30 min. did not affect the flow of impulses in the nerves or weaken it slightly. In 57 of 63 rabbits, during irradiation in a total dose of the order of several tens or units of roentgens, changes were observed in the flow of impulses in the vagus, depressor, sympathetic, and intestinal nerves. These changes took the form of an increase in the amplitude and frequency of the action potentials, indicating the presence of irritation phenomena in systems connected with the investigated nerves. Further, in approximately half the animals the flow of impulses became continuous in character. Normally the discharges followed each other in groups, but during irradiation impulses were also recorded between the grouped discharges. In some experiments the strengthened flow of impulses became weaker after cessation of the irradiation, while in others it remained slightly stronger for 5 to 20 min. Since autonomic nerves contain, besides efferent fibers, a large number of afferent fibers conveying impulses from the corresponding interoceptors of the internal organs, the role of the receptors in these reactions was determined. In this case too, irradiation led to an increase in the amplitude and frequency of the action potentials in the nerves that were studied. It was concluded that ionizing radiation creates a state of excitation in the corresponding receptors. (auth)

3915 ELECTROPHYSIOLOGICAL INVESTIGATION OF THE FLOW OF IMPULSES IN THE DEPRESSOR NERVE DURING THE ACTION OF IONIZING RADIATION. Ming-hua Chang (Inst. of Experimental Medicine, Leningrad). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 965-8(Sept. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 37-42(Sept. 1963).

The electrical potentials of the depressor nerve were recorded in the same animal before and after irradiation. Experiments were carried out on 15 cats and 10 rabbits anesthetized with urethane. The potentials were picked up by means of ordinary silver electrodes with a distance of 3 to 4 mm. between the poles, and recorded by a four-beam cathode-ray oscillograph using an amplifier. At the same time as the nerve potentials were recorded, the respiratory

movements of the chest, the ECG, the time marker and, in some experiments, the general blood pressure were registered on photographic film. Before irradiation the flow of impulses was recorded from the central and peripheral ends of the left depressor nerve which had been divided. The animals then received whole-body x irradiation. The total dose received by the cats was 550 R, and by the rabbits 800 to 1000 R. Recordings were taken from the same nerves under the same conditions 10 and 30 min. and 1, 2, and 4 hr. after irradiation. Results indicated that irradiation led to functional changes in the receptor apparatus of the vascular system. (auth)

3916 ON THE CAPACITY OF MINERAL RADON WATER TO RESTORE FUNCTIONING OF A FROG HEART DISTURBED BY THE ACTION OF CORTISONE AND ACTH. A. G. Saakyan and M. I. Kazanchev (Pyatigorsk Scientific Research Inst. of Balneology, Caucasian Mineral Waters, USSR). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 994-6(Sept. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 69-72(Sept. 1963).

Radon water restored the normal activity of the isolated frog heart after cessation of cardiac function caused by the administration of cortisone or ACTH. Possible reaction mechanisms involved are discussed. (C.H.)

3917 STRONTIUM-89-INDUCED BONE TUMOR IN THE RAT. K. Kowalewski and A. E. Rodin (Univ. of Alberta, Edmonton, Can.). Can. J. Surg., 7: 204-15(1964).

Six monthly injections of radioactive strontium (^{89}Sr) induced malignant changes in bones of adult rats. Excessive fibroblastic proliferation with subsequent differentiation into various types of sarcomatous lesions were observed. Both transplantation of these tumors and its growth in tissue culture were successful. Bone hexosamine, hydroxyproline and total N were increased in ^{89}Sr-treated rats in the premalignant period, which might be due to the fibroblastic stimulation of bone connective tissue by radiation. Some of the bone components in both ^{89}Sr-treated rats and nonirradiated animals were decreased after treatment with a corticoid. An anabolic androgen protected the bones of rats from this effect of corticoid when both steroids were given simultaneously. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3918 EFFECT OF CONTINUOUS LOW-LEVEL GAMMA-IRRADIATION ON SUCCESSIVE GENERATIONS OF DAHLBOMINUS FUSCIPENNIS (ZETT.) (HYMENOPTERA: EULOPHIDAE). D. F. Riordan (Canada Dept. of Agriculture, Belleville). Can. J. Zool., 42: 685-8(July 1964).

The chalcid, a hymenopterous parasite, was γ irradiated continuously through seven generations; the experiment was halted at this point by lack of host cocoons (D. fuscipennis was reared on larval cocoons of the sawfly Neodiprion lecontei). The dose rates were 10, 5, and 2.5 R/hr. At 10 R/hr the population failed to reach the third generation. After two generations at 5 R/hr the population was reduced in numbers to 20% or less of the control population, but managed to survive for the seven generations. At 2.5 R/hr the numbers in the first five generations were reduced below those of the controls, but had completely recovered by the sixth generation. The time, in days, beoviposition and emergence in the seven generations of the untreated controls was 19 to 21. The corresponding times for the groups that were treated at 2.5 R/hr were 21 to 25 days. When treatments were at 5.0 R/hr, the times to emergence were 23 to 29 days, and for the single generation surviving treatment at 10 R/hr 27 days (total dosage 6240 to 6480 R). At 5 R/hr the population appeared to have reached a roughly stable state after the second generation. The results of the treatment at 2.5 R/hr showed that the numbers of females in the first five generations of progeny fluctuated to some extent but in the same pattern as those in the corresponding control generations. The population had fully recovered by the sixth and seventh generations, and recovery was also apparent in the generations relieved from irradiation. This is further indicated by the manner in which the development times shortened after the second generation. This was a self-accelerating process, as a shorter development time resulted, in turn, in a lesser total dose. These results suggest selection of a radiation-resistant strain of the parasites. The small numbers of insects used precluded assessing separate, but interdependent, subeffects; however, data from the 5-R/hr treatment show that reduced fertility of the females was the major cause of the lesser numbers of females in the successive generations. (BBB)

3919 LEUKEMOGENIC EFFECT OF RADIOACTIVE PHOSPHORUS IN ADULT AND FETALLY EXPOSED BALB MICE. E. A. D. Holmberg, C. Dosne de Pasqualini, E. Arini, A. Pavlovsky, and S. L. Rabasa (Instituto de Investigaciones Hematologicas, Academia Nacional de Medicina, Buenos Aires). Cancer Res., 24: 1745-8(Nov. 1964).

The leukemogenic effect of radioactive phosphorus was studied in adult females and fetally exposed males and females of the BALB strain of mice. The results obtained in this series of experiments indicate that fetally exposed females are more sensitive to the effect of the agent than males (46.5 and 10.8 per cent, respectively). It was observed that the incidence of leukemia in fetally exposed females is negatively correlated with the dose. In males, on the other hand, there is no such correlation and the over-all incidence is not increased (10.8 per cent). Adult and fetally exposed females submitted to sterilizing doses of ^{32}P show the same incidence of leukemias (42 and 36.3 per cent, respectively). The experiments herein reported demonstrate that ^{32}P is definitely leukemogenic. (auth)

3920 CHANGES IN THE REGION OF VENTRAL SPINAL COLUMNS IN RATS IRRADIATED BY A LETHAL DOSE OF X RAYS. J. Zvára, R. Příbyš, and I. Hradil (Karlova Univ., Hradec Kralove, Czechoslovakia). Cesk. Morfol., 12: 40-9(1964).

Changes of motor neurones in the cervical intumescentia of rats irradiated totally by a dose of 3000 R were studied. The structure of pericaryons and axons was studied in preparations stained by Einarson's gallocyanin, Mayer's hematoxylin and eosin and by the silver-natron impregnation method. On the grounds of the Nissl image and impregnation image two normal forms (active and postactive cells) and two pathological forms (homogenized and pycnomorph cells) were defined. While in normal forms there was a harmony in the qualities of the nucleus and the plasma (concerning the volume and color), in the pathological ones this co-ordination was disturbed. The frequency of cellular types was studied in the following stages of the experiments: 12 hours, 1st, 2nd, 3rd, and 4th day after irradiation and in animals killed just before imminent spontaneous death. Symptoms of degeneration represented by the presence of pycnomorph cells were found on the 3rd day; maxima of these changes were reached in animals killed just before death. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3921 DETERMINATION OF RADIORESISTANCE OF NUCLEOTIDES IN SOLID PHASE. Marcel Lacroix and Albert Van de Vorst (Université, Liege and Institut d'Astrophysique, Cointe-Sclessin, Belg.). Compt. Rend., 259: 2027-8(Sept. 21, 1964). (In French)

Some constituents of RNA were studied by electron spin resonance to determine their resistance to ionizing radiations. It was shown that the increase of the radiosensitivity observed in passing from nucleosides to nucleotides is largely due to the fact that, in this latter case, the base does not act as a protector element, contrary to what occurs in nucleosides. It was established that the accumulation of phosphate groupings does not modify the effect provoked by one of these. (tr-auth)

3922 EFFECTS OF X RAYS ON THE CONTENT OF COENZYME I AND ON THE ACTIVITY OF COENZYME I-GLYCOHYDROLASE IN EMBRYONAL HEART OF THE CHICKEN IN ORGANOTYPIC CULTURE. Georges le Douarin and Jean-Michel Kirrmann (College de France and C.N.R.S., Paris). Compt. Rend., 259: 2153-5(Sept. 28, 1964). (In French)

The content of coenzyme I (NAD) in the embryonic heart of the chicken was decreased 25% 10 min after irradiation with 30,000 R. This effect is attributed to a liberation in the

cytoplasm of a part of the NADase of the nucleus, followed by a modification of the permeability of the nuclear membrane. (tr-auth)

3923 ON THE TREATMENT AND PROGRESS OF FIBROTIC BONE DYSPLASIA. E. L. Schaefer and A. Sturm, Jr. (Medizinische Akademie, Duesseldorf, Ger.). Deut. Med. Wochschr., 88: 464-6(Mar. 8, 1963). (In German)

Investigations indicate that x radiation or Ra treatment of fibrotic dysplastic bone foci may induce malignant changes in a large number of cases where it is used. Fibrotic bone dysplasia can be monosteotic or polyosteotic. It is frequently associated with neuroendocrine disturbances, such as pubertas praecox, pigmentation anomalies, premature growth cessation, hyperthyroidism, diabetic metabolic or mental disturbances, or sometimes with eye diseases, such as congenital cataracts. The cause of this illness is unknown, but it is though that it might be initiated during embryonic development. Calcium, vitamin D, and temporary ovarian castration with radiation have been used as treatment, but with rather unconvincing results. Growth hormone has been administered when growth appeared about to be reduced. Intratrochantal osteotomy and orthopedic devices have been used. Malignant transformation of fibrotic bone dysplasia is rare. Only ~10 cases where sarcomas developed have been reported in the literature. Because it is so potentially harmful, and also because the effectiveness of x radiation is rather doubtful, this type of treatment seems to be contraindicated. Surgical removal of a fibrotic dysplastic bone should be limited to cases where such procedures will not restrict body movement or function. The increased danger of fractures during this bone disorder is no indication for surgical removal, because the fractures heal very readily. Radical surgical procedures should be considered only if there is very clear evidence that the dysplasia is progressive. (BBB)

3924 THE LOCALIZATION AND BEHAVIOR OF CORTICOSTEROIDS IN RAT SUPRARENALS IN THE COURSE OF ACUTE RADIATION SICKNESS. J. W. Borowicz (Inst. of Experimental Pathology, Academy of Sciences, Warsaw). Folia Histochem. Cytochem., 1: 253-8 (1963).

Examination of rat suprarenals by histochemical methods for detecting ketosteroids showed changes in the occurrence and localization of cortical ketoalcoholic steroids to appear following irradiation of the animals with a large dose of x-rays. These changes support the hypothesis of the stressor action of ionizing radiation (increased reaction within the first hours following irradiation, return to normal after a day, and decay in the next days). On the 3rd and 5th day after irradiation the reaction for ketosteroids was found to occur in the glomerular zone only, while it was absent in the fascicular. However, in animals which were injected with ACTH on the 5th day after irradiation the intensity and localization of the reaction were the same as in healthy animals. From this it may be concluded that lower hormonal activity of the adrenal cortex is a consequence of radiation injury to the pituitary and of the resulting ACTH deficiency. The theory of the stimulating effect of ACTH on the fascicular zone but not on the glomerular is also supported by this observation. The histochemical method for detecting ketoalcoholic steroids is highly valuable for morphological determination of the adrenal cortex activity in its individual anatomical layers. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3925 EFFECT OF GAMMA IRRADIATION ON THE SPOILAGE OF CANNED PORK LUNCHEON MEAT. Lloyd L. Kempe and J. T. Graikoski (Univ. of Michigan, Ann Arbor). Food Technol., 18: 134-6(July 1964).

The ability of ^{60}Co γ irradiation to prevent the development of botulinum toxin in cans of pork luncheon meat (PLM) was studied. The meat was canned under vacuum and inoculated with one ml of a water suspension containing 10,000 to 1,530,000 Clostridium botulinum Type A or B spores. Even unirradiated cans did not spoil during several months storage at 30°C, and uninoculated controls were also usually stable. When canned PLM was similarly inoculated and then irradiated with 0.19 to 4.4 Mrad, the meat was as stable as the controls; however, irradiation of the canned PLM before inoculation shortened the storage life of the meat. With Type B spores, preirradiation with 0.186 Mrad before inoculation resulted in marginally toxic spoilage within two months; at 0.372 Mrad and above, large amounts of toxin were present and the PLM spoiled in about three months. With Type A spores, preirradiation with 2.15 Mrad or more induced toxic spoilage within one month. This induced spoilage indicates that the antiseptic action of preservative ingredients in the PLM was reduced by irradiation. However, it is noteworthy that when PLM was first inoculated and then irradiated, it was stable in spite of the apparent reduction in antiseptic activity. This indicates that C. botulinum spores of both Types A and B are relatively easily inactivated when irradiated in PLM. The PLM used contained nitrate and nitrite as preservatives and it is known that nitrite and nitrate concentrations may both be changed in meat by irradiation. Irradiation may reduce the nitrite concentration resulting in an increase in nitrate. Since nitrite inhibits the growth of C. botulinum and nitrate keeps the redox potential high, alteration of the concentration of these chemicals by irradiation could alter the stability of cured meats during storage. Decreased nitrite or nitrate concentrations would probably shorten the storage life of PLM, whereas increases might lengthen it. (BBB)

3926 TISSUE REACTIONS AND DOSE RELATIONSHIPS IN RATS FOLLOWING INTRAPULMONARY BETA RADIATION. S. Laskin, M. Kuschner, B. Altshuler, and N. Nelson (New York Univ., New York). Health Phys., 10: 1229-33(Dec. 1964).

Squamous cell carcinomas of bronchial origin were produced in lungs of rats exposed to the beta radiation of ^{106}Ru and ^{32}P sources. Utilizing intrabronchial pellets implanted by surgical techniques, the spacial relations of the emitting pellet to the bronchial origin of tumor were defined, permitting dose in Rads to the target tissue to be directly calculated. Previously reported experiments with electroplated ^{106}Ru sources have shown a Rad dose-related incidence of tumor yield. These doses based on time of death with cancer rather than time of initiation of malignant change included some wasted radiation. Serial sacrifice experiments with rats exposed to 5 μC ^{106}Ru sources demonstrated earlier finding of cancer providing for minimum estimates of the period of wasted radiation. Spontaneous deaths in the serial sacrifice pool confirmed the cancer incidences of previous experiments at the 5 μC level. A hollow plastic pellet was devised for the examination of dose rate effect on tumor induction with the use of isotopes of varying half life. An initial experiment with Phosphorus-32 delivering doses of 10^3, 10^4, 10^5 Rads resulted in a yield of tumors at these levels comparable to the yield from the same dose in Rads delivered by ^{106}Ru pellets. Thus, within these limits, there was no dose-rate dependence for tumor yield. (auth)

3927 MUTATIONS INDUCED BY THE ACTION OF METAL IONS IN PISUM. II. FURTHER INVESTIGATIONS ON THE MUTAGENIC ACTION OF METAL IONS AND COMPARISON WITH THE ACTIVITY OF IONIZING RADIATION. Goesta Von Rosen (Hilleshög Sugar Beet Breeding Inst., Landskrona, Sweden). Hereditas, 51: 89-134 (1964).

The mutagenic effects of ions of Cu, Fe, Co, Zn, Mn, Cs, Mg, and Na on young plants of sugar beets of two Pisum varieties were compared with the effects of radiation and nitrogen mustards. The contribution of metal ions in the induction of plant mutations and possible applications in plant breeding programs are discussed. (C.H.)

3928 SOME UNIFOLIATA MUTANTS IN VICIA FABA L. Jan Sjoedin (Swedish Seed Assn., Svalöf). Hereditas, 51: 279-90(1964).

Three unifoliata mutants in Vicia faba L., two induced and one spontaneous, were studied morphologically, particularly with regard to flower structure. Studies were also performed to elucidate dominance and allelic rela-

tionships in this material. One spontaneous unifoliata mutant received from Gottschalk was also included in the studies of the allelic relationships. Of the four unifoliata mutants studied, the two spontaneous ones are morphologically less deviating from the normal type than the two induced ones. The last mentioned types are obligate, the single leaf character persisting throughout the entire vegetative period. The spontaneous types show this character only during the first part of ontogenesis whereafter they gradually change to normal leaf type. When the induced types were crossed to the normal material, a monohybrid segregation for the unifoliata character was obtained. The corresponding segregation ratio for the spontaneous mutant showed a good fit to a 15:1 segregation, thus indicating that in this mutant two genes are responsible for the unifoliata character. Studies of the allelic relationships have indicated that three different loci are involved in expressing the unifoliata character. The two induced mutants and the spontaneous one received from Gottschalk are mutations in the same locus while two other loci are responsible for the unifoliata character of the other spontaneous type. Possible causes for the differences between induced and spontaneous unifoliata mutants are discussed. (auth)

3929 THE EFFECT OF X-IRRADIATION ON DIPLOID AND POLYPLOID LUZULA. Hedda Nordenskioeld (Royal Agricultural Coll., Uppsala). Hereditas, 51: 344-74(1964).

Dormant seeds of Luzula were irradiated with rising doses of x rays, from 10,000 to 300,000 R. Four different species were treated: two true tetraploids, L. multiflora (2n = 24) and L. groenlandica (2n = 24); the diploid L. pallescens (2n = 12), and the endo-nuclear polyploid L. sudetica (2n = 48). The response to x irradiation of the four species was determined by studying their lethality, their vitality, and their fertility. The lethality is low compared with the strength of the dose. Fifty per cent lethality lies at about 200,000 R for the diploid L. pallescens and the endo-nuclear polyploid L. sudetica, and for the two tetraploids, L. multiflora and L. groenlandica, it lies at a dose higher than 300,000 R. The vitality, determined by the total height of the plants, is more sensitive to x irradiation, the height already decreasing at 60,000 R for L. pallescens and L. sudetica, and for the tetraploid L. multiflora at a dose of 100,000 R. The most sensitive character is fertility. This is already disturbed after a treatment of 20,000 R for L. sudetica, at a dose between 20,000 R and 40,000 R for L. pallescens, and for the tetraploid L. multiflora at a dose of 40,000 R. Complete sterility is reached for all three investigated species at a dose of about 100,000 R. The mutation frequency of the irradiated material was determined by calculating the frequency of X_1-plants, segregating in green and white seedlings in X_2 or X_3. (auth)

3930 RELATIONSHIP OF THE FREQUENCY OF X-RAY-INDUCED EXCHANGE BREAKS TO THE CHROMOSOME LENGTH IN THE PMCs OF TRILLIUM KAMTSCHATICUM PALL. Shigeyuki Tanifuji and Senzi Takizawa (Hokkaido Univ., Sapporo). Idengaku Zasshi, 38: 360-6 (Apr. 1964).

In the pollen mother cells (PMCs) of Trillium kamtschaticum, the frequencies of the combinations of two chromosomes which participate in an exchange were investigated with several materials irradiated at various stages of the meiotic prophase. In the materials irradiated in late October, the observed frequencies in the various combinations were roughly in accord with their expected values calculated on the basis of the proportionality to chromosome length and the random distribution of chromosomes in a prophase nucleus. On the contrary, in the cases irradiated later than the end of October, certain greater deviation from the expectation was demonstrated. Comparing the relative frequencies of the exchanges between homologous chromosomes, it was clearly shown that the values decrease in the cases of irradiation at November, December, and January of the next year. Results indicate that chromosome pairing takes place later than October in the PMCs of this plant. (auth)

3931 STUDIES ON THE INDUCTION OF BUD SPORTS IN TULIPS BY IONIZING RADIATION. I. MORPHOLOGY AND DEVELOPMENT OF THE BULBS. M. Nezu and S. Obata. Idengaku Zasshi, 38: 386-91(Apr. 1964).

The vegetative propagation, CO_2 production, and water content of tulip bulbs favorable for induction of bud mutations were examined. The results showed that the floral organ which will give a flower in the first spring is formed in mid-November, and at the same time the main bud which will flower in the second season is indicated by 2 to 3 scales. The growing point which will give a flower in the third spring, is differentiated inside those scales during the first spring. The bulbs did not have flowers if they grew up to be less than 8 cm in circumference. Irradiation was carried out mostly during September to November, and the color sporting of petals was observed during four successive vegetative generations after irradiation. This procedure explains changes induced in the floral organ will appear in the first spring and a change induced in the main bud that will appear in the flower of the second or third spring respectively. CO_2-production of tulip bulbs during 120 days of storage was measured by the gas flow method and the value of $4-10 \times 10^{-3}$ mg/1 g fresh wt/1 hr was obtained, which approaches that obtained from dry seeds of other plants. The greater susceptibility of tulip bulbs to radiation is probably due to their greater water content, which, in this experiment, was determined to be 56 to 58%. (auth)

3932 STUDIES ON THE INDUCTION OF BUD SPORTS IN TULIPS BY IONIZING RADIATION. II. ACUTE AND CHRONIC RADIATION EFFECTS ON PLANT GROWTH AND BULBIL YIELD. M. Nezu and S. Obata. Idengaku Zasshi, 38: 392-8(Apr. 1964).

The influence of acute and chronic x irradiations on the growth of tulip plants was examined. The bulbs of two varieties, Diana (diploid) and Keizerskroon (triploid, were irradiated in two ways; namely, by 1 kR total amount with doses varying between 10 and 200R/h, and by chronic 6.8R/h irradiation, the total amount varying between 2 and 8 kR. The effects on plant growth, measured in terms of stalk length, flowering, survival, and bulb yield were examined in the first vegetative season. The results are summarized. (auth)

3933 THE RADIOSENSITIVITY OF OOGONIA AND OOCYTES IN THE CHICK EMBRYO. Gillian C. Hughes (Univ. of Birmingham, Eng.). J. Embryol. Exptl. Morphol., 12: 273-87(June 1964).

This study was undertaken to determine the rate of radiation-induced cell death in oogonia and oocytes of the developing chick, and to correlate the extent of such damage with morphologic and cytologic changes occurring in the ovary at the time of exposure. Fertile eggs (F_1 generation White Leghorn x Rhode Island Red) were x irradiated on the 9th, 11th, 13th, 15th, 17th, and 19th days of incubation with doses of 200 and 400 R. The results from histologic examination of the ovaries of two-day-old chicks showed that the percentage increase in germ cells is consistently lower after exposure to 400 than to 200 R. Thus irradiation depresses the regenerative capacity of surviving oogonia, the degree of depression being dose-dependent. As compared with unirradiated controls, irradiation on the 9th, 11th, and 19th days reduced the percentage increase in the number of germ cells between two days after exposure and the 2nd day after hatching. Ovaries removed two days after exposure to 200 R on day 13, however, and to either 200 or 400 R on days 15 and 17, showed a greater percentage increase in the number of germ cells than normal ovaries. At two days after irradiation, histologic changes in nongerminal elements were minor, and cortical cysts were not observed. Irradiation did not appear to retard the development of germ cells within the first two days after irradiation. Some degenerating germ cells were greatly enlarged; it was noted, however, that advanced stages of spontaneous atresia are also frequently associated with an increase in nuclear diameter. The present results therefore show that doses of 200 and 400 R of x rays are sufficient to cause marked radiolesions in the germ cells of female chick embryos, the response to radiation being dependent both on the dose

administered and on the age of the embryo at the time of exposure. (BBB)

3934 MIXED MESODERMAL TUMORS OF THE BODY OF THE UTERUS FOLLOWING IRRADIATION THERAPY FOR CARCINOMA OF THE CERVIX. A REPORT ON FOUR CASES. K. J. O'Connor (Chelsea Hospital for Women, Eng.). J. Obstet. Gynaecol. Commonwealth, 71: 281-3(1964).

Mixed mesodermal tumors of the body of the uterus were described as a rare sequel of irradiation of the uterus. Four cases of mixed mesodermal tumor following intracavity and external irradiation for carcinoma of the cervix are reported. One case in which there was a double uterus developed the tumor in the opposite cavity to that which received the original treatment. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3935 GAMMA-IRRADIATION OF SPORES OF BACILLUS SUBTILIS. A. M. Cook and T. A. Roberts (London Univ.). J. Pharm. Pharmacol., 16: 529-32(Sept. 1964).

The effects of irradiation on spores freeze-dried from water and glucose and lactose solutions were compared as well as their viability with that of suspensions in water and glucose after irradiation. It was shown that freeze-drying from a 5% aqueous solution of glucose produced a marked protection of the spores subjected to spent-fuel γ irradiation over the range 2.5 to 12.5×10^5 Rad. Freeze-drying from aqueous suspension produced no protection. Irradiation in 5% aqueous glucose and in aqueous suspension gave log % survivor/dose regressions with similar slopes. Experiments with rigidly controlled water content show sensitization to irradiation of spores irradiated in the presence of, and stored in the presence of, O_2. Sensitivity is a function of water content, decreasing sensitivity occurring with increasing water content; therefore, intracellular dehydration is therefore unlikely to be the reason for the increased radiation resistance demonstrated. Freeze-drying from 5% aqueous glucose under the conditions described produced a glass. This may be regarded as a supercooled syrup, amorphous in nature, and containing some water. A true glass is impermeable to gases, but if crystallization occurs, pores form and permit passage of gases. Since the glass forms during freeze-drying, and is impermeable, spores encased in it may exhibit typical anoxic radiation resistance, which is greater than resistance in the presence of air. If the glass is incompletely formed, or unstable, as with lactose, only some of the spores will remain protected by the residual entire glass. Alternative explanations are also considered. As the bacterial spore is permeated by glucose a glass may form within the spore, and stabilization of toxic free-radicals may then occur. There is also evidence that the state of molecular aggregation has a marked effect on the radiation decomposition of α-D-glucose. It may be possible for the most resistant aggregation to protect spores encased in it against radiation damage. (BBB)

3936 X-RAY SENSITIVITY OF SARCOMAS. Edgar Pick (Hebrew Univ., Jerusalem). Lancet, 1: 833(Apr. 11, 1964).

An alternate hypothesis is offered to explain a previous report by Haddow, et al. that irradiated cancer cells, when used to immunize animals bearing transplantable cancers, slow the growth of these cancers. This presents an original approach to the immunologic treatment of cancer, but, it is suggested, another working hypothesis could better explain the findings. It was previously proposed that ionizing radiations can induce formation of new antigens in cells and therefore enhance immunologic rejection of these artificial body-alien components. In previous work, ^{32}P-induced granulocytopenia was more severe in rats previously injected with marrow from irradiated donors, incorporated in Freund's adjuvant. Similarly, an in vitro irradiated tumor autograft could provide a strong, modified antigenic stimulus in an otherwise tumor-tolerant organism. The tumor cells still viable after irradiation of the original tumor are likely to have their antigenicity modified in a manner similar to that of irradiated autograft. This makes the remaining 10% of the tumor the ideal and specific target for an immune response elicited by the autograft. Delayed tumor growth could be explained on this reasoning. (BBB)

3937 ON THE RADIATION SENSITIVITY OF EXTRAMEDULAR HEMOPOIESIS. G. V. Hevesy, D. Lockner, and K. Sletten (Univ. Stockholm). Med. Welt, 455-460(1964). (In German)

The effects of ^{60}Co γ radiation doses from 150 to 2000 rad on hematopoiesis in fresh water fish were investigated. The fish weighed between 100 and 200 g and were kept in water at 18 or 5°C. A large part of the ^{59}Fe fed to the fish was accumulated in the organs. After about 20 days at 18°C approximately 70% was found in the erythrocytes. A significant decrease of the ^{59}Fe incorporation in the red blood cells occurred first after irradiation with 750 rad. The greatest depression of the ^{59}Fe incorporation was observed with 1500 rad after 7 days. After this radiation dose a sharp decrease of the red blood value was detected. This drop is ascribed not to an inhibition of erythropoiesis, but to a hemolysis of the erythrocytes. The lifetime of the erythrocytes at 18°C has a minimum value of 150 days, and erythropoiesis occurs very slowly. It was established that erythrocytes of fish blood irradiated in vitro reacts, in contrast to mammalian blood, at low irradiation doses (4000 rad) with significant hemolysis, and 150 rad causes a detectable decrease in the number of white blood cells. The hemoglobin formation is significantly slower at 5°C than at 18°C. Only 4% of the injected ^{59}Fe is incorporated in the hemoglobin at 5°C. This incorporation was not affected by irradiation with 10,000 rad. The erythrocytes of the fish (tenches) contain, in addition to the iron incorporated in the hemoglobin, nonhemoglobin iron. After in vitro irradiation in the presence of ^{59}Fe the content in nonhemoglobin iron of the red blood cells increases. (tr-auth)

3938 OBSERVATION OF THE ULTRASTRUCTURE OF IRRADIATED LUNG. R. Garbagni, S. Chiarle, and B. Bellion (Università, Turin). Minerva Nucl., 8: 245-52 (Sept.-Oct. 1964). (In Italian)

The changes induced in the lungs of rabbits irradiated with a single dose of 4,000 R (beta 31 Mev) were investigated under a normal and an electron microscope after 15 and 40 days. The existence of a connectival proliferative response was confirmed. Examination under the electron microscope showed that this extends also to the alveolo-capillary wall and made it possible to analyze the findings (especially at the cellular and sub-cellular levels) which make up the picture corresponding to the response of the lung to irradiation. (auth)

3939 EFFECT OF IRRADIATION ON THE URIDINE DIPHOSPHATE GLUCOSE GLYCOGEN TRANSFERASE (GLYCOGEN SYNTHETASE) ACTIVITY OF THE LIVER OF FASTING RATS. D. Bonsignore, C. Canonica, and L. Lenzerini (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy and Università, Genoa). Minerva Nucl., 8: 282-4(Sept.-Oct. 1964). (In Italian)

The uridine disphosphate glucose glycogen transferase (glycogen synthetase) activity of the liver was investigated in fasting rats and in irradiated fasting rats. The enzyme was assayed as specific activity and as total activity. In both instances no significant difference was found between the fasting animals and the fasting irradiated animals. (auth)

3940 RADIOSENSITIVITY OF DROSOPHILA SPERMATOGONIA. III. COMPARISON OF ACUTE AND PROTRACTED IRRADIATION EFFICIENCIES IN RELATION TO CELL KILLING. Per Oftedal (Norwegian Radium Hospital, Montebello). Mutation Res., 1: 63-76(1964).

The applicability of available data, discussed on the basis of 64 references to the literature, to the interpretation of radiation dose-effect curves for point mutations in terms of a mathematical model is considered. Heterogeneity in the exposed population as regards cell killing and mutation induction sensitivities is assumed, and a complete correlation between these sensitivities is postulated. The model is based on data from acute radiation treatment of Drosophila spermatogonia and predictions

based on it have been found to hold for protracted exposures. The results of other investigations at low acute doses also appear to be compatible with the model. In general, it was found that low doses are more efficient than higher ones, when heterogeneous cell populations are exposed. The decrease in efficiency presumably takes place through the killing off of a class of highly sensitive cells. These cells are probably at a certain stage of the mitotic cycle, and may, in Drosophila spermatogonia, constitute about 10% of the total cell population. Low dose rates kill fewer of the sensitive cells, and therefore lead to higher mutation yields in an intermediate dose range, as shown by two previous investigations. Thus, it appears that the model described can be used to predict non-linear genetic dose-effect curves in treatments of heterogeneous cell populations with doses within the region of one to three times the LD_{50} for the most sensitive cells in the population. The slope of the curves will be steeper in the region of the lowest doses than in that of high doses. The model further predicts that with protracted doses, the same initial slopes will be found as for the lowest acute doses, but that the decrease in the steepness should take place at a relatively higher total dose. For a quantitative interpretation of a given dose-effect curve in terms of this model, it is necessary to have data on cell survival in the relevant dose region. For protracted treatments, normal cell cycle length as well as cell cycle disturbances under treatment should also be known. These conditions are not fulfilled at present for any material, so that the model may serve for the present mainly as a guide in planning further experiments and in curve fitting, as well as to indicate the limitations of the present understanding of the dynamics of genetic radiation effects. (BBB)

3941 CLINICAL INVESTIGATIONS ON THE URINARY 17-KETOGENIC STEROIDS. PART IV. STUDIES ON THE CHANGES OF URINARY 17-KETOGENIC STEROIDS. EXCRETION BY AGE DURING ADOLESCENCE OF THE CHILDREN EXPOSED TO THE ATOMIC BOMB IN UTERO. Yuji Arai (Kyoto Univ.). Naika Hokan, 10: 235-43(1963).

A biochemical study was carried out during a three-year period from 1958 as a joint investigation of Kyoto University and the Atomic Bomb Casualty Commission (ABCC) under a research project to study adolescents who were exposed in utero. Determination of urinary 17-ketogenic steroids (17-KGS) was performed in 275 adolescents drawn from a group of 874 children who were either exposed to the atomic bomb in utero in Nagasaki or who entered the city after the bombing (nonexposed controls). The measurements were done in same subjects between the age of 13 and 15 at three-month intervals. In the unexposed control group the 17-KGS excretion showed a rapid increase around the age of 14 in males and a slight increase around the same age in females. The mean values in males seemed to become higher than in females around the age of 14. Changes of 17-KGS excretion showed no statistically significant difference between the groups proximally exposed (under 2000 m from the hypocenter) or distally exposed (between 3000 and 5000 m) and the unexposed control children of both sexes. However, the mean values of 17-KGS excretion of every group tended to decrease in the order of unexposed, distally exposed, and proximally exposed groups in males after the age of 14½ and in females at the age of 15. Changes of 17-KGS excretion showed no statistically significant difference between the exposed and unexposed groups in terms of 1 to 3 month, 4 to 6 month, and 7 to 10 month of gestation at the time of bombing. From these results it appears that there was no effect of the atomic bomb radiation in the adolescents exposed in utero with regard to their adrenocortical function. (BBB)

3942 FACTORS AFFECTING THE EXPANSION OF THE STEM CELL POOL IN TRANSPLANTED MOUSE BONE MARROW. M. Bennett, G. M. Shearer, A. C. Upton, and G. Cudkowicz (Oak Ridge National Lab., Tenn.). Nature, 204: 351-3(Oct. 24, 1964). (ORNL-P-10)

The effects of experimental modifications thought to decrease or increase the need for the production of differentiated hemic cells by the transplanted marrow were investigated. Specifically, the effects of varying the number of marrow cells transplanted, of hypertransfusing the recipients of the marrow with erythrocytes or lymph node cells, and of grafting marrow from female donors into isoantigenic male recipients were explored. It was inferred that mouse marrow cells transplanted into lethally irradiated recipients may be unable to regenerate a normal-sized hemopoietic stem cell population if the requirements placed on them for differentiated cells are too great in relation to the available supply of transplanted stem cells. However, if large enough numbers of marrow cells are transplanted, or if the recipients are supplied directly with differentiated blood cells during the critical stages of hemopoietic repopulation, reproduction by donor marrow stem cells may be adequate to restore rapidly the pool of such cells to normal levels. Conversely, if the requirements for production of differentiated blood cells are increased, as is the case in isoantigenic recipients, a marginal marrow stem cell pool may be further depleted to meet these requirements. (auth)

3943 INFLUENCE OF DIET AND IODINE-131 INJECTIONS ON THE SURVIVAL OF DYSTROPHIC MICE. Robert F. Borgman (Clemson Coll., S. C.). Nature, 204: 389-90 (Oct. 24, 1964).

The survival of dystrophic mice receiving a commercial laboratory diet was about doubled by the injection of ^{131}I at 3 weeks. A high-protein semi-purified diet prolonged survival approximately three-fold. The level of sodium and potassium in the high-protein semipurified diet, however, did not influence survival, and a combination of ^{131}I injection, weekly injections of methylandrostenediol dienanthoylacetate and the high-protein semi-purified diet did not prolong survival beyond the time observed with the high-protein semi-purified diet alone. None of the treatments affected the characteristics of the syndrome in any other way. (auth)

3944 EARLY RESPONSE OF PINUS THUNBERGII TO ACUTE γ-IRRADIATION. James P. Okunewick, Stephen Herrick, and E. N. Carlsen (Univ. of California, Los Angeles). Nature, 204: 394-5(Oct. 24, 1964).

The response of Pinus thunbergii seedlings to 715 ± 40R of γ radiation was studied under laboratory conditions. Length of terminal and lateral candles was greatly reduced in the irradiated plants. Male strobili in irradiated plants reached the same state of elongation as those in the controls, but failed to show any pollen release. Female strobili did not develop in the irradiated trees. Bud formation in irradiated candles was considered indicative of the ability of the species to survive and recover from significant doses of acute γ radiation. (H.M.G.)

3945 PRESERVATION OF THE HETEROZYGOUS DIPLOID CONDITION IN INDUSTRIAL MICRO-ORGANISMS. K. D. Macdonald (Microbiological Research Establishment, Salisbury, Wiltshire, Eng.). Nature, 204: 404-5(Oct. 24, 1964).

Multiple labeling by x-ray treatment is considered as a method for increasing the possibilities of restricting genetic recombination. (auth)

3946 CONGENITAL RETICULOSIS (MYELORETICULOSIS) IN A NEWBORN PREMATURE INFANT. G. Škodáček and J. Babala. Neoplasma, 11: 199-206(1964).

This report concerns a case of congenital leukemic reticulosis (myeloreticulosis). The case is described from the clinical, hematologic, and histological aspect. Injury of the germinal cells through repeated contact with electric current, possibly caused by the effect of x rays to which the father (electrician) had been exposed, are considered as possible etiological factors. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3947 MORPHO-HISTOCHEMICAL INVESTIGATIONS IN VIEW OF DETERMINING THE TYPE, DEGREE AND DYNAMICS OF ALTERATIONS OF THE CENTRAL NERVOUS SYSTEM IN GUINEA-PIGS IRRADIATED WITH ROENTGEN RADIATION "MICRODOSES." T. Vasculescu,

A. Rosenberg, L. Diacu, and C. Crăcium. Oncol. Radiol., 2: 357-70(1963).

Investigations carried out for determining the role of technical factors in micro-irradiation of the CNS showed that in the dog the type (hypoxia) and prevalent localization of the alterations in the centers correspond to those found in the guinea pig; the degree of the alterations is more marked and less reversible than in the guinea pig under similar technical irradiation and examination conditions; demyelinization lesions become more accentuated in the dog in time and, within the same interval, gradually disappear in the guinea-pig. The findings stress the role of phylogenetic development as regards the degree of radiosensitivity and the process of adaptation of the CNS to ionizing radiations. The conclusions will be confirmed by similar determinations on other species now under investigation (birds, rats, tritons). (Excerpta Med., Sect. XXIII, (Oct. 1964))

3948 QUANTITATIVE PIGMENT STUDIES ON RADIATION-INDUCED CHLOROPHYLL MUTANTS OF PISUM SATIVUM. II. THE FERTILE AND STERILE CHLOROPHYLL MUTANTS. W. Gottschalk and F. Mueller (Universität, Bonn). Planta, 62: 1-21(1964). (In German)

The chlorophyll of 48 fertile and 4 sterile x-ray-induced mutants of Pisum sativum was analyzed. The total chlorophyll was 12 to 17% of value for normal forms. The ratio of chlorophyll a to chlorophyll b varied between 2.8 and 9.8. For 4 of the mutants no chlorophyll b could be detected. In 10 mutants gradients of pigment contents were present in the pinnules, stipules, or leaf succession on the stems. For some mutants the chlorophyll contents of the upper leaves decreased to 30% the value for lower leaves, for others it climbed to 250%. Fertility was also found to decrease generally with decreasing chlorophyll. However, one mutant with only 12% of the normal chlorophyll amount was still capable of carrying out an approximately normal ontogenesis for seed formation. No clear correlation between chlorophyll content and fresh weight could be found. (tr-auth)

3949 LATE INJURIES AFTER THOROTRAST USE. H. R. Marti and Y. Heilbronn (Universitlit, Basel). Praxis (Bern), 51: 1068-75(Oct. 18, 1962). (In German)

The characteristics of x ray photographs that indicate tissue changes produced by Thorotrast administration are specific enough that evidence from past history is not always necessary to confirm its use previously. Although serious late injuries may result from Thorotrast use this is not always so. Cases without serious functional disturbances are often observed, but these are rarely published. For instance, in a series of 6 patients reported, one had panmyelopathy, one renal failure, and a third developed severe liver necrosis. However, in the other three there was no evidence of injury from Thorotrast that was known to be deposited. Even though symptoms do not appear, there is always a possibility they they will during the lifetime of the patient, because there is no exact period of latency when late injuries may be excluded as a possibility. Even if the known previous history of the patient excludes Thorotrast, detection of radioactivity at skin surfaces will indicate Thorotrast incorporation. No other substance will give the same contrast pattern in an x ray photograph. In liver and spleen the deposition is flecked or reticular, and in kidney shading extends through throughout the parenchyma. In extrarenal deposits, such as in the adjacent lymph nodes, the contrast is marked. Superficial deposits can be removed surgically, but for the most part, continuous observation is all that is possible. The spleen and adjacent lymph nodes can be removed, but these organs are relatively insensitive to radiation. The liver and bone marrow deposition remains unaltered. Because Thorotrast kidney deposition is bilateral, nephrectomy for a single kidney can be considered if it loses all function. All patients with internally deposited Thorotrast should be examined each year, with careful abdominal palpation, blood studies, and kidney and urine examinations. X ray studies should be avoided because of the radiation hazard. There are many more persons who have been injected with Thorotrast then the literature indicates, and each physician who performs thoracic fluoroscopic or x ray examinations should be able to detect these patients. By doing so, the patient may be spared improper diagnosis, and can be treated with more appropriate measures that will conform to what can be done for Thorotrast poisoning. 68 references. (BBB)

3950 EFFECT OF HEAD X-IRRADIATION ON THE UPTAKE OF RADIOPHOSPHORUS BY RAT BRAINS. John R. Bergen, Heather D. Seay, Charles K. Levy, and Werner P. Koella (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Proc. Soc. Exptl. Biol. Med., 117: 459-62(Nov. 1964).

Whole head irradiation in rats with 20 Krad increases ^{32}P uptake by the brain. These findings confirm the results of Stajic et al, and strongly suggest that ionizing radiation enhances the permeability of the blood-brain barrier to phosphate. By introducing the time parameter, the time of onset of the permeability change was approximated. It begins after a delay of at least 24 hours after exposure to irradiation. This delay time explains the negative findings of Florsheim et al, who could not have detected the delayed effect because of the temporal arrangement of their experiments. It now must be determined if ionizing radiation of the whole brain or its parts increases the permeability to other molecules, particularly to biogenic amines, and whether whole head irradiation affects the permeability of the brain in toto or whether there are loci of predilection in their reaction to x-ray treatment. (auth)

3951 EXPERIMENTAL STUDY OF THE RES: EVALUATION OF ITS RADIOSENSITIVITY WITH RADIOGOLD. E. Marzano, E. Santoro, and M. Trinci (Universitâ, Rome). Progr. Med., 19: 690-8(1963).

The functional modifications of reticulo-endothelial system, after γ irradiation from a Co source, were studied in rats. The reticulo-endothelial activity of the liver and spleen was studied after doses of 100 to 400 R and at a time distance between 1 and 7 days from irradiation. Colloidal radioactive gold, which allows a direct evaluation of the alterations induced in the reticulo-endothelial system, was used. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3952 THE FUNCTIONAL CHANGE OF ERYTHROCYTES IN VIVO DURING IRRADIATION OF GUINEA PIGS WITH A LETHAL DOSE OF γ-RAYS. L. V. Orlova (Inst. of Biology and Physics, Moscow). Radiobiologiya, 4: 649-55(1964). (In Russian)

Ten guinea pigs were given a lethal, ^{137}Cs dose of 700 R. Blood samples were taken: 2 to 8 days before irradiation; before the irradiation itself; 1 to 5 min after the irradiation; and in the course of the radiation sickness (1 to 4 weeks) until the death of the animal. The change in the hemolytic resistance of the erythrocytes was followed by mixing the purified cell suspension with a borate buffer and carrying out an alkaline hemolysis at 32°C and a pH of 9.2. The variation of time for the onset of erythrocyte hemolysis in the isotonic, alkaline medium was taken as a parameter of radiation damage. This parameter did not show any variation over a period of 5 minutes to 4.5 hr, but did show some variation over a period of a few days in normal guinea pigs. Immediately after the irradiation (1 to 5 min), the erythrocyte hemolysis time in the alkaline solution decreased. Then the hemolysis time began to increase 1 to 6 days after the irradiation, and attained a maximum before the death of the animal. These changes in the resistance of the erythrocytes to hemolysis are an indication of irreversible pathological changes in these cells due to radiation sickness of the organism. (TTT)

3953 THE CONTENT OF SH-GROUPS IN THE WHOLE BLOOD OF NORMAL GUINEA PIGS AND IN THE BLOOD OF GUINEA PIGS UNDERGOING RADIATION SICKNESS. T. A. Sviderskaya (Inst. of Radiation Protection, Leningrad). Radiobiologiya, 4: 660-5(1964). (In Russian)

Guinea pigs were given an x-ray dose of 450 R, and the SH-content of the blood was determined by an amperometric titration with silver nitrate before irradiation and on the 2nd, 5th, 10th, 15th, 20th, 25th, and 30th day after the ir-

radiation. Since erythrocytes are the main source of thiol compounds in the blood, the variation in erythrocyte content of the peripheral blood was also followed. The normal SH-content of 1105 μmol per 100 ml of blood fell to 945 μmol/100 ml on the second day after the irradiation, attained a minimum of 332 μmol/100 ml on the 15th day after the irradiation, and rose again to a normal value of 1057 μmol/100 ml on the 30th day after the irradiation. The minimum erythrocyte count was also observed on the 15th day after the irradiation. The SH-content dropped to 15% of the initial value in animals dying during the period of severe radiation sickness. Animals surviving the first dose of 450 R were subjected to a second dose of 600 or 500 R. With the animals given a second dose of 500 R, a 15% decrease in SH-content is first observed on the 8th day after the irradiation with the largest decrease in SH-content (52% of the initial value) being observed on the 15 to 17th day after the irradiation. Then the SH-content rises to its initial value at about the 35th day after the irradiation. (TTT)

3954 THE EXCRETION OF VITAMIN B_{12} DURING SEVERE RADIATION SICKNESS. L. L. Shepshelevich and L. S. Rogacheva (Lenin Inst. of Hematology and Blood Transfusion, Moscow). Radiobiologiya, 4: 666-7(1964). (In Russian)

The utilization of B_{12} by irradiated rats was investigated by subjecting the rats to an x-ray dose of 500 R, and then giving the rats an intramuscular dose of 0.5 μC of ^{58}Co, which corresponded to 0.4–0.8 γ of vitamin B_{12}. The urine and feces were collected daily, and the ^{58}Co γ radiation was determined on a well-type scintillation counter. The total amount of excreted ^{58}Co was 11.7% in the irradiated animals, and 12.4% (9.5% in the urine and 2.9% in the feces) in the control rats. Thus, the data show that the excretion of vitamin B_{12} in irradiated rats does not differ from the excretion of vitamin B_{12} in the unirradiated control rats. (TTT)

3955 THE EFFECT OF SMALL INTERNAL DOSES ON A NUMBER OF ASPECTS OF WATER, MINERAL, AND NITROGEN EXCHANGE IN ANIMALS. REPORT I. THE VARIATION IN WATER ELIMINATION WITH THE INTRODUCTION OF SMALL AMOUNTS OF RADIOACTIVE SODIUM INTO THE ORGANISM. Ya. I. Azhipa and G. A. Filyashina (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Radiobiologiya, 4: 668-74(1964). (In Russian)

Doses of 10, 50, and 250 μC of ^{24}Na per kg of body weight were introduced into the stomachs of 12 dogs who were equipped with urethers. Diuresis, filtration, and reabsorption in the kidneys were determined 5 to 10 times before the administration of ^{24}Na, and on the 16th hour, the 2nd, 3rd, 4th, 5th, and 6th days after administering the radioactivity. A dose of 250 μC led to a sharp increase in spontaneous diuresis of 100 to 200%. On introducing a water-milk mixture into the stomach through a fistula, the ability of the kidneys to eliminate water was markedly increased in four dogs at 16 to 20 hrs after administering the ^{24}Na activity. The effect did not last beyond 15 days. The greatest change in secretion was observed in the 1st week after administering the ^{24}Na. A dose of 50 μC/kg caused an increase in the spontaneous and aqueous diuresis in 4 out of 5 dogs. At lower doses greater variations were apparent. The data show that the kidneys are quite sensitive to internal irradiation. (TTT)

3956 A NUMBER OF FEATURES IN THE DISTURBANCE OF STOMACH GLAND ACTIVITY ON INTRODUCING SODIUM-24 INTO AN ORGANISM. S. R. Perepelkin (Inst. of Higher Nervous Activity and Neurophysiology, Moscow and Sechenov Radiobiological Lab., Moscow). Radiobiologiya, 4: 675-84(1964). (In Russian)

Two dogs were given a dose of 50 μC/kg. Another dog (Pal'ma) was given a total of 10.288 μC (the total absorbed dose was 38.47 rads) in each of 13 administrations a month apart. The dog Ryzhik was given 7.56 μC each time in 11 separate administrations (the total absorbed dose was 26.78 rads). Pal'ma was fed a meat and milk diet, while Ryzhik was kept solely on a meat diet. The amount of stomach juices and the enzymatic activity of the juice were determined after administering a ^{24}Na dose of 50 μC/kg. A slow-down in the secretion of stomach juices was observed with an increasing number of ^{24}Na doses, especially in the case of a meat diet. A milk diet was much less likely to cause a decrease in the output of stomach juices. The output of stomach juices was variable in character. An increased output after the administration of ^{24}Na activity was likely to be followed by a prolonged decrease in the output of stomach juices. If the vagus nerve was cut, the stomach glands were not stimulated in the usual fashion by the meat diet. Adaptation of the organism to internal irradiation by radioactive sodium was not observed. The secretion of stomach juices has a tendency to return to normal on stopping the administration of ^{24}Na. (TTT)

3957 THE SIGNIFICANCE OF DOSE STRENGTH IN REACTIVE CHANGES OF THE INTESTINAL MUCOUS MEMBRANE ON IRRADIATING MICE WITH ^{60}Co. G. S. Strelin and K. F. Galkovskaya (Central Research Inst. of Medicinal Radiobiology, Leningrad). Radiobiologiya, 4: 685-92(1964). (In Russian)

White mice were given a ^{60}Co, γ dose of 1000 or 2000 R over a period of 1 to 2 hours. The mice were also given the same dose of 1000 or 2000 R over a period of 0.5, 1, 2, 3, 4, and 8 days. The dose rate was varied by changing the distance between the ^{60}Co source and the mice. On the 1st, 2nd, 3rd, and 4th days after the irradiation, the mice were killed in order to perform a histological examination of the crypts in the small intestine. The dimensions of the crypts, the number of cells in a crypt, and the average number of mitoses in a crypt were determined as a function of irradiation time at doses of 1000 R and 2000 R spread out over a period of $\frac{1}{24}$, $\frac{1}{2}$, 1, 2, 3, and 8 days. The number of cells per crypt were decreased by 40% at a dose of 1000 R, and by 60% at a dose of 2000 R one to two days after the irradiation. The mitotic activity fell to zero a few hours after the irradiation, and remained at a low value for 2 to 3 days, especially with a dose of 2000 R. The dimensions of the cell in the crypts increased by 30% at a dose of 1000 R, and almost doubled at a dose of 2000 R. The extent of the radiation damage decreases on decreasing the dose rate and increasing the irradiation time for the same total dose. An irradiation time of 2 to 3 days at a dose of 1000 R and of 4 days at a dose of 2000 R caused relatively little radiation damage to the crypt cells. (TTT)

3958 THE EFFECT OF IONIZING RADIATION ON THE STATE OF RECUPERATIVE PROCESSES IN THE ORGANISM. A. V. Lebedinskii, V. M. Mastryukova, Z. N. Nakhil'nitskaya, and A. D. Strzhizhovskii. Radiobiologiya, 4: 693-700(1964). (In Russian)

Significant information in the wide field of recovery processes in an organism after irradiation is reviewed. These processes can be subdivided into one group in which the genetic balance of the tissue is maintained (secretary systems in an organism), and into another group dealing with excitation in the nervous system and others. It is noted that a high mitotic activity in a tissue indicates a protective reserve of cells because a removal of viable cells takes place in a tissue having high mitotic activity such as the epithelium of the cornea. The entropy of such a system is high, and the system can better resist any injury tending to suppress the mitotic activity. It is pointed out that the genetic damage to a structure becomes more readily manifested when the resting cells are stimulated into mitotic activity. A formula is presented from which the number of daughter cells perishing on the average due to a pathological mitosis can be calculated. The number of chromosomal aberrations in the tissue continually decreases with time. The role of depolarization and repolarization in recuperative processes is pointed out. (TTT)

3959 ASPECTS OF THE REACTIONS OF IRRADIATED ANIMALS TO A NUMBER OF FUNCTIONAL STRESSES. A. N. Lanin (Central Research Inst. of Medicinal Radiobiology, Leningrad). Radiobiologiya, 4: 701-2(1964). (In Russian)

The reactions of irradiated rabbits to the internal administration of physiological solution and to blood loss were investigated. The rabbits of both sexes were given

single, whole-body x-ray doses of 600 and 1250 R. It was found that the unirradiated rabbits could endure on the average the administration of 29.2% of the body weight as physiological solution which was transfused into the external jugular vein. After the transfusion an increase in arterial pressure that kills the animal can be observed. One day after the irradiation the tolerances to injection of physiological solution remained about the same with 29.7% for the 600 R dose, and 31.8% of body weight for the 1240 R dose. The tolerance to liquid injection fell to 20.5% of the body weight for a 600 R dose on the 15th day of radiation sickness. With a 1250 R dose, the liquid injection tolerance decreased to 17% on the 4th day after the irradiation. The lethal blood loss in the unirradiated animals was on the average 2.87% of the body weight. With a 600 R dose, the lethal blood loss decreased to 2.31% of the body weight on the 10th day after the irradiation and again increased to 3.2% of the body weight on the 15th day. With a 1250 R dose, the lethal blood loss decreased to 2.06% of the body weight on the 7th day after the irradiation and rose somewhat to 2.26% on the 10th day after the irradiation. (TTT)

3960 RADIATION DAMAGE OF THE CHROMOSOMES IN A CULTURE OF HUMAN, EMBRYONIC FIBROBLASTS. A. A. Prokof'eva-Bel'govskaya, L. F. Gorskaya, L. G. Dubinina, and G. V. Yatrova (Inst. of Biology and Physics, Moscow). Radiobiologiya, 4: 708-14(1964). (In Russian)

A ^{60}Co, γ dose of 10, 25, and 50 R to a culture of human fibroblasts results in damage to 2.86, 6.60, and 13.28% of the cells respectively (the chromosomal rearrangements are counted in anaphase 32 to 34 hours after irradiation). The number of chromosomal breaks are 0.13 cells/R at a 10 R dose, 0.19 cells/R at a 25 R dose, and 0.22% cells/R at a 50 R dose. A comparative analysis of chromosomal damages in metaphase and in the postmetaphase stages showed that twice as many chromosomes are damaged in metaphase (26.8% at a 50 R dose) as in anaphase-telophase (12.0% at a 50 R dose). The increase in the number of cells with damaged chromosomes in metaphase is due to the appearance of additional dicentric chromosomes and fragments during this period. (22 references). (TTT)

3961 IRRADIATION DOSE AND NUCLEUS CHANGES IN HUMAN CELL CULTURES AT DIFFERENT PHASES OF THE CELL CYCLE. N. P. Dubinin, L. G. Dubinina, and N. I. Nesterova. Radiobiologiya, 4: 715-25(1964). (In Russian)

Human embryonic cell cultures were given ^{60}Co, γ-ray doses of 25, 50, and 100 R. The percent chromosomal rearrangements were summed at 2, 12, 19, 16, 30, and 70 hours after the irradiation in order to obtain the effect of radiation on the cycle as a whole. At doses of 25 and 50 R, the number of chromatid rearrangements, which occur on the basis of a single-hit mechanism, is directly proportional to the dose. Chromosome rearrangements, which require two hits, are approximately proportional to the square of the dose. At a dose of 100 R, things are more complex. The number of chromosome rearrangements are less than that expected according to the square of the dose, and the number of chromatid rearrangements are less than would be expected from a direct proportionality to dose. Only if the tissue is fixed 19 hours after irradiation (assumed synthesis phase), is the number of chromatid rearrangements proportional to the dose. The distribution of seven main types of chromosome and chromatid rearrangements are given for doses of 25, 50, and 100 R. Changes in the ability of the distal fragments to fuse is a minimum at a 25 R dose, a maximum at a 50 R dose, and intermediate at a 100 R dose. (TTT)

3962 THE EFFECT OF SMALL DOSES OF γ RADIATION ON THE MITOTIC ACTIVITY OF HUMAN FIBROBLASTS IN A TISSUE CULTURE. V. M. Kozlov (Inst. of Biology and Physics, Moscow). Radiobiologiya, 4: 726-30 (1964). (In Russian)

After incubating for 44 to 64 hours in a thermostat at 37°C, a culture of human cells was given a γ-ray dose of 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 R. Cell fixation was carried out each 10 hours over a period of 70 hours for a dose of 25 to 50 R, and at 6, 12, 22, 28, and 38 hours after irradiation for a dose of 5 to 20 R. The mitotic index was calculated from a count of the number of metaphase platelets per 3000 cells. The controls were subjected to the same manipulations, but were not irradiated. The experimental results show that a γ-ray dose of 5 to 20 R has no effect on the mitotic activity, although with a dose of 20 R the mitotic activity of the irradiated sample never once exceeded that of the control, but remained at about 90% of the control value. On irradiating the cells with a dose of 50 R, the mitotic activity decreases to 26% of the control 10 hours after the irradiation. It increases to 66.7% of the control 20 hours after the irradiation, and falls to 61.9% of the controls 30 hours after the irradiation. The mitotic activity rises to 90.5% at 40 hours, decreases to 81.8% at 50 hours, is slightly above the control at 60 hours (>100%), and decreases again to 91.5% of the controls at 70 hours after the irradiation. Thus, a γ-ray dose of 25 to 50 R lengthens the cell cycle of human cells to 60 hours. (TTT)

3963 THE FREQUENCY OF OCCURRENCE OF PROTOTROPHIC MUTATIONS ON IRRADIATING YEASTS OF DIFFERENT PLOIDY. I. P. Arman. Radiobiologiya, 4: 731-7(1964). (In Russian)

Yeasts of the Saccharomyces cerevisiae strain were available of different ploidy: the haploid in 02587 (a tr_1^- ur_1^-), the diploid 87D (aa tr_1^- tr_1^- ur_1^- ur_1^-), and the triploid X-354 (α aa tr_1^- tr_1^- tr_1^- ur_1^- ur_1^- ur_1^-). These strains are isogenous, homozygotic auxotrophs requiring supplements of tryptophan and uracil for growth. A thin layer of suspended cells were spread out over a large area in a Petri dish, and were subjected to irradiation with ^{60}Co γ rays or with ultraviolet rays. The survival curves show that the haploid strain was the least radioresistant, the diploid strain was intermediate in resistance and the trihaploid was the most radioresistant. The frequency of mutants independent of tryptophan or of uracil increases linearly with dose. The number of reversions (mutants independent of tryptophan or uracil) increases more rapidly with dose in the haploid 02587 than in the diploid and triploid. The H/D (haploid to diploid) ratio is greater than one, and increases sharply with increasing dose. The ratio of uracil-independent mutants in homozygotic diploids and triploids (the D/T ratio) is equal to about 2/3 in the case of γ-irradiation, and varies from 1.4 to 2.0 in the case of ultraviolet irradiation. The D/T ratio does not depend on dose. A genetic analysis of the reversions showed the absence of recessive gene-suppressors. A possible mechanism of the effect is described. (TTT)

3964 REASONS FOR DIFFERENCES IN RADIATION SENSITIVITY OF CLOSELY RELATED PLANTS. PART I. S. A. Valeva (Inst. of Biology and Physics, Moscow). Radiobiologiya, 4: 764-9(1964). (In Russian)

Two varieties of maize, Nemchinovskii and Podmoskovskii, were studied in the form of air-dried seeds (8% moisture) and seeds that had sprouted after being soaked 36 hr in water at 22°C. Radiation doses were 1 and 7 kR of γ (^{60}Co) and 100, 300, and 800 rad of fast neutrons. The data showed that in reaction to both low and high doses of γ and neutrons, seeds of the N. variety were more radiation resistant than those of the P. variety. The sprouted seeds showed similar relative radiation sensitivities. The nature of the chromosome damage was different in the seeds and sprouts: the chromosome bridge-to-chromatid was 4 to 5 in the seeds and one in the sprouts. Simulation of possibly damaging conditions created by irradiation indicated that the difference in radiation sensitivity of the two varieties is not related to their difference in stability to the active radicals (OH and HO_2) formed in radiolysis of water. (TTT)

3965 THE VARIABILITY OF POTATO SEEDLINGS IN THE FIRST GENERATION UNDER THE INFLUENCE OF γ RAYS, FAST NEUTRONS, AND ETHYLENE IMINE. N. D. Tarasenko (Inst. of Cytology and Genetics, Novosibirsk, Siberia). Radiobiologiya, 4: 770-4(1964). (In Russian)

The mutagenic action of γ rays, fast neutrons, and ethylenimine on the variations of the qualitative and quantitative morphological characteristics of the seedlings was

investigated. It was hoped that the experimental mutation method might be useful for the selection of the potato plants. Certain indicators of the variability of the treated and untreated plants were compared; they included the height, starch and albumin content. The variations were analytically treated, determining the average values and experimental errors in each case. The series included exposure to 15,000 R of γ radiation, 1000 rad of fast neutrons and treatment with 0.1% ethylenimine for 24 hrs, and the untreated control group. The results showed that all the treatments increased the variability of the quantitative and qualitative indicators of the first generation, including the morphologic indices of the tubers and of the above-the-ground portions of the plant, their tuber-forming ability and the duration of the vegetative period, the size of the plants, the number and weight of the tubers and their starch and albumin content. Treatment with fast neutrons was found to be most effective from the overall viewpoint; x rays and fast neutrons induced the largest variations in the starch content while treatment with fast neutrons and ethylenimine resulted in the largest number of favorable mutations. (TTT)

3966 THE DOSE FIELD FOR THE IRRADIATION OF ANIMALS WITH HIGH-ENERGY PROTONS. V. P. Afanas'ev, I. B. Keirim-Markus, E. E. Kovalev, S. S. Kuznetsova, V. A. Sakovich, L. N. Smirennyi, I. K. Sokolova, and M. A. Sychkov. Radiobiologiya, 4: 775-81(1964). (In Russian)

In order to study the biological effect of the 100 to 600-Mev protons, portions of the bodies of dogs, rats, and mice were irradiated in the synchrocyclotron of the Joint Institute for Nuclear Investigations at Dubna. The dose field must be known in order to ensure uniform exposure of the animals; in addition, steps must be taken that the accompanying radiations do not exceed a certain value. The synchrocyclotron emits a 657 ± 5 Mev beam, in the form of 100 to 400-μsec pulses at the rate of 100 pulses/sec; the dispersion of the beam was about 40′ and the flux density reached 4×10^{11} p/cm^2-sec, corresponding to a tissue dose of 4000 rad/sec. Ten cm-thick Pb absorbers were used for the actual irradiation, in order to widen the scattered beam. The angle of multiple scattering which reduced the flux by 15%, amounted to 2.5°, resulting in the formation of a 40 to 50-cm diameter uniform field, required for the irradiation tests. The usual dosimetric methods, in particular the ferrosulfate dosimeter, were found suitable for measuring the tissue doses of 100 to 700-Mev protons. A bilateral irradiation method was developed, allowing to administer doses to the body of the dogs, keeping them uniform within ±10%. While exposing large animals to such high-energy protons, the secondary radiation may reach 20 to 30% of the absorbed dose. The composition of the radiation within the phantom must be further investigated. (TTT)

3967 ELIMINATION OF CHLORIDE IONS BY IRRADIATED RATS. M. Rakovich, V. Gregora, and G. Venigova (Charles Univ., Prague). Radiobiologiya, 4: 782-3 (1964). (In Russian)

The changes in the metabolism of electrolytes in irradiated rats were studied by determining the Cl^- ion concentration in the urine of rats exposed to 100 R of x radiation. The animals had access ad libitum to water and the standard diet after the exposure. The Cl^- concentration of the collected urine was found to be markedly lowered. The total amount of urine during the first 2 days was practically unchanged but decreased from the third day on. Thus, the Cl^- ions removed through the urine were reduced as a result of the exposure, but the Cl^- concentration of the blood serum remained unchanged. The data agree well with the previous finding that the removal rate of Na of irradiated animals through the urine is also reduced. Unfed animals exhibited a similar behavior. It is therefore concluded that this behavior is due to disturbances in the feeding process of the irradiated rats. (TTT)

3968 THE EFFECT OF TOTAL EXPOSURE TO X RADIATION ON THE SOLUBLE ALBUMINS OF THE SPLEEN. A. M. Makhlina (Zhdanov State Univ., Leningrad). Radiobiologiya, 4: 783-5(1964). (In Russian)

Morphologic and metabolic changes of the spleen play an important role in the pathogenesis of radiation sickness. The problem was studied by examining the composition of albumins from the organs of irradiated rabbits, attempting to uncover the radioinduced changes in the heat resistance of the albumins from the blood serum and the spleen of the animals. The materials were investigated by the paper electrophoresis method, details of which were reported previously. The tests were carried out during the acute period of the sickness, on the fourth day after exposure to 2000 R of x radiation. It was found that the soluble spleen albumins can be divided into 9 anodic and 2 cathodic fractions. The irradiation caused a decrease in the 1st and 2nd fractions and an increase in the 3rd and 7th fractions. By heating to 60°C, sharp differences were found between the properties of the spleen albumins from the irradiated and unirradiated animals. The blood serum albumins heated to 56°C also exhibited differences, such as the decrease of the total albumins and the γ globulin and the increase of the $\alpha_1-\alpha_2$ and the β globulin fractions in the samples collected from irradiated animals. (TTT)

3969 THE FUNCTIONAL STATE OF THE VESTIBULAR APPARATUS OF WHITE MICE IN THE CASE OF RADIATION SICKNESS. O. N. Chulkova (Inst. for Scientific Research for Health Physics, Leningrad). Radiobiologiya, 4: 785-6(1964). (In Russian)

The radioinduced changes in the vestibular apparatus of 9-month-old white mice, subjected to acceleration after exposure to 600 R of x radiation, were examined. The animals were alternately rotated in a centrifuge and kept at rest for 10-sec periods 6 hours, 5, 10, 15, 20, 25, and 30 days after irradiation. It was found that the unirradiated mice required a decreasing amount of time to recover the normal position after acceleration. The irradiated animals exhibited a changing behavior in this respect. Up to the fifth day, the time required to return to the normal position was reduced; then it was increased until the tenth day, followed by a second period of decrease and increase. (TTT)

3970 INCLUSION OF ^{32}P INTO SOME PHOSPHORUS-CONTAINING FRACTIONS OF THE ORGANS OF IRRADIATED RATS. A. I. Nikolaev and Seid-Mansuri Beyuk Mir-Abdulla (Tashkent State Univ.). Radiobiologiya, 4: 787-8 (1964). (In Russian)

The metabolism of P of the nucleic acids was investigated only during the first days of radiation sickness; therefore, the incorporation of ^{32}P into nucleic acids, phosphoproteids, phospholipids and the acid-soluble, P-containing fraction of the liver and the spleen of rats was followed for periods ranging from 30 minutes to 240 days after exposure to 100 or 600 R of x radiation. The animals were killed 2 hrs after receiving a hypodermic injection of $Na_2{}^{32}HPO_4$ at a rate of 10 μcurie/100 g of body weight. The results indicated that the irradiation interfere with the P metabolism even during the first hrs after exposure. The change of the incorporation of ^{32}P exhibited a wavy character: the radioactivity of the fraction increased and decreased alternately. The high doses caused more marked up-and-down variations than the low doses in the activity of the P-containing fractions but no clear correlation could be established between the distribution of the radioactive P and the fraction; this is probably due to the complex interaction and the varying radiation-sensitivity of the phosphorylizing ferments. (TTT)

3971 QUANTITATIVE CHANGES OF THE SEROTONIN, HISTAMINE AND OF THE CONSTITUENT ELEMENTS OF THE BLOOD OF IRRADIATED RABBITS TREATED WITH ANTIBIOTICS. Z. A. Popenenkova (Inst. of Epidemiology and Microbiology, Moscow). Radiobiologiya, 4: 788-90(1964). (In Russian)

The effect of prolonged treatment with antibiotics on the amount of various components in the blood of rabbits exposed to 950 R of whole-body x irradiation was investigated. The animals were injected intraperitoneally twice daily for 21 days with 100,000 units of penicillin and streptomycin and were treated orally with 100 mg of levomycetin; the treatment was started within 12 to 15 hours after the irradiation. The serotonin, histamine, leukocyte, and eosinophil content of the blood of the irradiated and/or

treated and control animals was determined before and 1, 3, 7, 10, 14, and 21 days after irradiation. The tests indicated that the serotonin content of the only-irradiated animals was reduced by a factor of about 10 within 1 day, by a factor of 12 after 7 days and by a factor of 3 after 21 days with respect to the original concentration. The thrombocyte content was about 2, and 1.5 after 1, 7, and 21 days, respectively. The 2 components varied in parallel fashion, except for the period about 14 days after exposure. The extended antibiotics therapy did not affect the radiation-induced decrease of these components. Treatment of unirradiated rabbits with antibiotics also resulted in a marked decrease of the serotonin content by factors between 3.5 and 10 but the changes in the thrombocyte concentration are not considered statistically reliable. The control animals, treated with physiological solution, did not exhibit any of these changes. The histamine content was reduced by a factor between 10 and 40 as a result of the exposure. Treatment of the irradiated animals with antibiotics somewhat mitigated this effect. No correlation could be established between the quantitative changes of serotonin, histamine and the leukocytes and eosinophils in the blood of the irradiated and treated animals. (TTT)

3972 THE EFFECT OF VARIOUS γ RADIATION DOSES ON THE GERMINATION OF THE RHIZOMES OF THE PEPPERMINT PLANT. N. M. Berezina and E. I. Korneva (Inst. of Biology and Physics, Moscow). Radiobiologiya, 4: 793-5(1964). (In Russian)

The development and the yield of peppermint depends greatly on the quality and quantity of the plant's rhizomes; new growth of the roots affects the culture of the plant. Previous studies revealed that low-level γ irradiation of the stem induces the formation of new buds, affecting also the number of branches and the inflorescence. Similar tests with potato plants showed also that while large doses inhibit the growth, low-level radiation has a stimulating effect. The problem was studied by exposing cuttings from the top, central, and lower sections of the roots to 0.1, 0.5, 8, and 40 kR of γ radiation from a ^{60}Co source. After irradiation, the sections were planted. It was found that exposure of the rhizomes to low doses, up to 1 kR, stimulates the growth of the plant. This effect was especially noticeable at the youngest portions, at the branching and at the upper sections of the root. High doses caused marked morphological changes and inhibited the growth of the plants. (TTT)

3973 GENERAL RADIOBIOLOGY AND SOMATIC RADIATION EFFECTS. O. Hug, O. Balk, U. Ehling, H. Gangloff, A. Kellerer, H. Miltenburger, M. Nuessel, L. Schachinger, and H.-J. Schliep (Universität, Munich and Gesellschaft für Kernforschung mbH, Nuremberg). Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 25, 7-103(1963). (In German)

Biophysical principles of radiation effects are discussed. Direct and indirect processes, microwave spectroscopy, oxygen dependence, the H_2O_2 hypothesis, reactivation, and mathematical interpretations of the dose-effect relation are considered. In vitro studies of the radiation biochemistry of proteins, peptides, amino acids, nucleic acids, radioinduced syntheses, and sensitizing and desensitizing substances are described. Radiation effects on enzymes and metabolism of cells, morphological studies, and investigations of cell permeability are considered. Somatic effects of radiation on multicellular organisms are discussed, including histology and histochemistry of acute radiation injuries, acute general reactions, late radiation injuries, and disturbance of embryonic development and growth. Time and space dose distributions, relative biological effectiveness, and other modifying factors are considered. The effects of incorporated radioisotopes are also described. (596 references). (M.C.G.)

3974 RADIATION GENETICS. H. Marquardt (Universität, Freiburg i. B.). Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschultz (Munich), No. 25, 105-22(1963). (In German)

A literature survey is presented on the genetic effects of radiation on viruses, bacteria, fungi, higher animals (germ cell mutations), higher animals (somatic mutations), higher plants (karyotic mutations), and higher plants (extrakaryotic mutations). (M.C.G.)

3975 IONIZING RADIATION: EFFECT ON GENETIC TRANSCRIPTION. Ernest C. Pollard (Pennsylvania State Univ., University Park). Science, 146: 927-9(Nov. 13, 1964).

Cells of Escherichia coli grown on maltose can be induced by the addition of thiomethyl galactoside to produce β-galactosidase. If cells are irradiated shortly after induction, the transcription of the DNA ceases; and the enzyme produced by the messenger RNA is observed to reach a maximum. From these data the calculated half life of unstable messenger RNA is given over a temperature range from 8.1 min at 10°C to 0.7 min at 45°C. The kinetics of cessation of transcription give information on both messenger RNA decay and rate of transcription. Arrhenius graphs for both these rates are given; the measured activation energies 11,000 cal/mole for decay and 22,000 cal/mole for transcription. (auth)

3976 EFFECT OF THYMECTOMY ON IMMUNE REACTIONS IN ADULT DOGS. Francisco E. Oliveras, William D. Kelly, Charles Merchant, and Robert A. Good (Univ. of Minnesota, Minneapolis). Surg. Forum, 14: 184-6(1963).

Thymectomy in newborn animals has been shown to have a marked effect on development of immune responses, and a lesser but still significant effect has been observed in animals thymectomized beyond the newborn period, especially when sublethal irradiation is used concomitantly. This procedure may be of value as an adjunct to other techniques used in attempts to induce homograft tolerance in adult animals. Homograft survival and antibody response to immunization with typhoid-paratyphoid and brucella vaccines were compared in adult controls and animals subjected to thymectomy and total-body irradiation. Groups were as follows: Group 1, skin homografts and immunizations at intervals up to one year after thymectomy; Group 2, 250 R total-body irradiation 30 days after thymectomy, with skin homograft and immunizations one month later; Group 3, skin homografts and immunizations one month after sham thymectomy. All skin homografts were rejected in a normal manner and time. Antibody response to immunization with typhoid-paratyphoid vaccine was significantly depressed in regard to the B antigen in thymectomized-irradiated animals. Response to brucella vaccine was diminished moderately in the thymectomized-irradiated group as a whole and markedly diminished in half of the animals. Thus, thymectomy in adult dogs appears to have no effect on homotransplant rejection even after a lapse of one year, but there was some evidence of impairment of antibody response when thymectomy was used in combination with sublethal irradiation. Further studies varying the dose of radiation and the time interval between radiation and testing are planned. (BBB)

3977 ATP CONTENT IN VARIOUS ORGANS OF ALBINO RATS DURING JOINT ACTION OF X-RAYS AND SOME CHLORETHYLAMINES ON THE ORGANISM. V. N. Totskii (Pirogov Medical Inst., Odessa). Ukr. Biokhim. Zh., 36: 618-23(1964). (In Ukrainian)

Studies were made on the ATP content in various tissues and organs of albino rats during the separate and joint action of x-rays (600 R) and some chloroethylamines. It was established that both penetrating radiation as well as embitol (16 mg/kg) induce very similar changes in the ATP content, manifested, as a rule, in a considerable decrease in most investigated tissues. In the joint action of ionizing radiation and embitol the effects were completely additive only in spleen tissue. In the tissues of the other organs either incomplete summation was observed, or it was less than in separate application of x rays and embitol. (auth)

3978 DARK REPAIR OF UV INDUCTION IN K12 (λ). Margaret Lieb (Univ. of Southern California, Los Angeles). Virology, 23: 381-8(July 1964).

After uv irradiation, the proportion of Escherichia coli K12 (λ) killed can be greatly increased by growing the cul-

ture in a medium containing caffeine, proflavine, or acriflavine. These substances, designated uv enhancers, apparently decrease survival of the lysogenic bacteria by increasing the probability that λ prophage will be induced to start replication. Growth for 30 min in a medium containing proflavine or caffeine increased the amount of free phage produced by the irradiated culture at the end of the latent period. Other experiments showed that exposure to uv-enhancing substances increased the number of plaque formers and decreased colony formers obtained after any given low dose of uv. The fact that the uv-enhancing substances increase killing of lysogenic bacteria more than that of nonlysogenic bacteria also indicates that they increase the probability of phage induction. The uv-enhancing substances prevent the repair, in the dark, of uv damage that can, at the time of some critical event in the metabolism of the cell, result in mutation, prophage induction, or cell killing. The rate of dark repair (DR), or perhaps the probability that it will occur at all in a particular cell, decreases with increasing uv dose. Although only caffeine, proflavine, and acriflavine were tested, it is suggested that these are merely representatives of two classes of substances, e.g., methyl purines and acridines, that interfere with DR of uv damage in microorganisms. It is believed that uv induction is the result of damage to DNA. The incorporation of 5-bromouracil into the DNA of lysogenic bacteria increases their sensitivity to induction by uv. How the methyl purines and acridines may prevent DR is discussed. (TCO)

3979 THE INDUCED MENOPAUSE. Reinhold Schwarz (Universität, Rostock, Ger.). Z. Aerztl. Fortbild., 55: 128-32(Feb. 1, 1962). (In German)

Not all women pass through a normal climacteric, because it is sometimes necessary to use medical procedures to induce the menopause before they have reached it naturally. The main reason that this procddure is required is the incidence of recurrent hemorrhages, which may indicate nonmalignant growths. If the different possibilities for treatment of recurrent nonmalignant hemorrhagic disturbances, that are not amenable to hormonal therapy, are considered in terms of their advantages and disadvantages, several procedures seem to be advisable. Use of β rays should be avoided because of the possibility of induction of tumors. For the same reason, and because of the possible complications, Ra filtered to exclude all but the γ radiation, should be used only in exceptional instances to destroy the endometrium. In women over 45 yr old the relatively nonhazardous method of x-ray menolysis for uterine extirpation is preferable. If any ovarian deficiencies should appear in women who may be disposed toward them, they can be treated by hormones. In spite of this, patients intended for this type of treatment should be selected carefully. For women who are less than 45 yr old, radiation is less to be preferred than surgery. If surgery is contraindicated, Ra should be used, because it has the advantage that it permits ovarian function to continue. In extreme cases, if these two methods are impracticable, x ray menolysis may be used. In the method generally used, 90 mg of Ra, contained in a brass capsule, is inserted into the uterus. The secondary β radiation from the Ra is absorbed in the container walls. After 20-hr exposure the radiation dose at a point 1 cm from the center of the uterus amounts to ~6000 R, and within the mucosa of the neck of the uterus it is ~2000 R. The advantages of intrauterine Ra treatment are that the method is simple, has an immediate effect, and has an assurance of favorable effect of close to 99%. Its disadvantages are the long exposure to radiation, a brief sloughing of the endometrium, and the danger of pyometra formation due to adhesions of the cervix uteri. Septic complications and retraction of the pelvic tissues have also been reported. (BBB)

3980 OSTEORADIONECROSIS OF THE COXAL FEMUR TIP AFTER RADIATION FOR GENITAL CARCINOMA. Paulo Hirayama (Staedtische Orthopaedische Klinik, Dortmund, Ger.). Z. Orthopaed. Ihre Grenzgebiete, 96: 286-90(Sept. 1962). (In German)

The assertion that mature bone is essentially insensitive to radiation has been denied, because experimental studies have shown that osteogenic tissues are more sensitive to radiation than skin or soft tissues. The bone salts produce more scattered radiation than the soft tissues do when exposed to radiation, so that the actual energy absorbed may be 6 times greater. The clinical radiation injury most important to the orthopedist is spontaneous fracture of the femur neck or head, as a postradiation side effect of treatment for genital carcinomas. These fractures have been attributed to a combination of injuries, direct radiation injury, indirect injuries caused by erosion of the vascular bed, or a summation of effects. The symptoms of osteoradionecrosis of the femur neck are not characteristic. Either there is a slowly increasing impairment of movement or patients complain suddenly of hip pains when climbing steps or retiring, so that it may be diagnosed as inflammation of the hip, sciatica, rhematism, or arthritis deformans. If the x ray injuries are more severe, other definite additional symptoms appear, ranging from x ray catarrh to extensive organ changes, such as atrophy and induration of the skin and subcutaneous tissues, scarification, depigmentation, dry skin, eczema, telangiectases, development of fistulas and edema, chronic persistent x ray ulcers, carcinoma, sarcomas, intestinal or bladder hemorrhages, or leukemia. Usually genital carcinomas do not metastasize to the neck of the femur or the pelvic region. Osteoradionecrosis of the cranial vault, the ribs, and the pubis or ischium do not cause any specific impairment, and are usually detected accidentally. Often they heal spontaneously. Nails and other supporting devices have given varying results, and sometimes the nail head in the peritoneal spaces may corrode. In general, treatment of necrosis of the femur neck and head is symptomatic. (BBB)

3981 POSTTRAUMATIC DERMATOLOGICAL COMPLICATIONS. K. Schwarz (Universität, Zurich). Z. Unfallmed. Berufskrankh., 55: 311-21(1962). (In German)

Posttraumatic skin atrophy caused by radiation often occurs in physicians and other medical personnel. The most frequent cause is exposure during fluoroscopy for fracture or foreign-body searches. Many times, single exposures cause the greatest damage. Since it is desirable to avoid unwanted magnification effects during foreign-body searches by bringing the object close to the focus, it is easily seen that erythema doses may result from extended transillumination used for difficult cases. At present, when increasing consideration is being given to radiation protection of patients, physicians, and other medical personnel, and new laws are being introduced for radiation protection, additional consideration should be given to replacement of older fluoroscopic equipment with image intensifiers. In this way radiation exposure of all personnel involved may be lowered by as much as a factor of 10. The dangers of ionizing radiation should not be underestimated and all of the prophylactic protective measures provided should be applied. (BBB)

3982 STUDIES OF X RAY MUTANTS OF OENOTHERA BERTERIANA. I. ON INCREASED TRANSLOCATIONS INDUCED BY TRISOMIA. Carl-Gerold Arnold (Universität, Erlangen, Ger.). Z. Vererbungslehre, 93: 417-34(1962). (In German)

In order to accumulate extrachromosomal mutants, seeds of Oenothera berteriana were irradiated with from 5000 to 100,000 R of x ray. Studies of the deviant plants of the X_1 generation and their progeny showed that it was not possible to obtain any visible plasmonic or plastomic mutations by use of a single radiation exposure of the seeds. The types of alterations found in the X_1 generation were frequently chimeras. Cytological studies showed that, as a rule, these had the normal chromosome number 2n = 14. Frequently, because of deviant chromosome configurations, translocations could be detected during diakinesis. The offspring of the X_1 deviants were never identical with their maternal plants. In most cases they reverted to normal, although throughout the various breeding units a very low incidence of additional deviant O. berteriana types was observed along with the normal plants. These results were reconciled with the types of chimera found in the X_1 generation. The deviant plants of the X_2 generation consisted of

mutants such as diploids, dimorphs, and monomorphic trisomes, heteroploids with a chromosome number between 2n + 2 and 4n – 1, and tetraploid forms. The deviant chromosome numbers of these X_2 mutants could not be ascribed to the radiation given, but were probably due to irregularities in the meiotic anaphase. Presence of a translocation chromosome was detected in a monomorphic trisomal X_3 mutant, whose chromosome ends were homologous to one another. Thus a 1 chromosomal ring was formed during diakinesis. Several deviant arrangements in the configurations expected were observed in many 15 chromosomal mutants. Their occurrence was probably due to other translocations. The agreement with numbers of spontaneously appearing trisomes indicated that the deviant configurations had no direct relation to irradiation, and the markedly increased rate of translocations between chromosomes was probably the result of trisomal constitution. The frequency of translocations indicates that factors related to the organism genotype itself are more often responsible for mutations than external factors. (BBB)

3983 EVALUATION OF THE ESTROGENIC FUNCTION OF THE OVARY FOLLOWING RADIUM THERAPY. A. Zoicinski and J. Robaczynski (Medical Academy, Wroclaw, Poland). Zentr. Gynaekol., 86: 203-5(1964).

Radium treatment appears appropriate in persistent hemorrhages from the uterus without neoplastic background and yields the expected results. On the basis of cytological examination of vaginal smears it appears that radium rays exert an influence upon the hormonal activity of the ovary. This influence can be seen four weeks after radium application; the function of the ovary is inhibited. This condition lasts in most cases 44 to 48 weeks. After this time the cytological picture of the vaginal smear changes; the estrogen effect is noticeable again. The impression is gained that the inhibiting effect of the radium rays upon the functional activity of the ovary is waning. Its restored hormonal activity is distinctly visible in the cytological picture. In some cases after this time recurrences of hemorrhages are seen, caused by proliferation of glands in the mucosa of the womb. Uterine hemorrhages persisting after radium treatment accompanied by a cytological picture characteristic of increased estrogen production can be the symptom of simultaneous pathological changes of the ovary, the presence of a hormonally active tumor. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3984 KOMBINIERTE STRAHLENSCHADIGUNGEN. (Compound Radiation Injuries). Boris Michailowitsch Chromow. Berlin, Akademie-Verlag, 1964. 322p.

The factors of an atomic explosion that can be damaging or injurious are reviewed. The classifications and characteristics of compound radiation injuries are described. Medication and treatment of the injuries, blood transfusions, surgical treatments, effects of radiation on wounds, thermal burns and radiation, and prognosis of combined radiation injuries are discussed. (M.C.G.)

3985 THE CROSSLINKING OF DNA AND PROTEIN BY ULTRAVIOLET LIGHT IN VIVO AND ITS BIOLOGICAL IMPORTANCE. Kendric C. Smith (Stanford Univ., Palo Alto, Calif.). 25p. (CONF-556-16).

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

When bacteria are irradiated with ultraviolet light, there is a dose-dependent decrease in the amount of DNA that can subsequently be extracted free of protein with detergent. This appears to be due to the crosslinking of the DNA with protein and the precipitation of the linked DNA when the denatured proteins are precipitated in the procedure used for the isolation of the DNA. The type of linkage between the DNA and the protein is unknown except that it resists the sequential attack of 2% sodium lauryl sulfate and 0.5 M KCl or 55% CsCl. The main evidence that the loss of DNA in vivo is due to the crosslinking of DNA and protein is that the crosslinking of DNA and protein can be demonstrated in vitro. X rays do not crosslink DNA and protein in vivo, but acridine orange and visible light cause the crosslinking of DNA and protein both in vivo and in vitro. By pulse labeling the DNA of Escherichia coli with tritiated thymine, it was shown that newly synthesized DNA is most sensitive to crosslinking and that this sensitivity shows a cyclic response keyed to the generation time of the bacteria. Under conditions of thymine starvation where the intrinsic sensitivity in the cells to killing by uv is markedly increased, there is a parallel increase in the sensitivity of the DNA of these cells to be crosslinked to protein. The similarity in the time sequence of these two events strongly suggests that the crosslinking may play an important role in the loss of viability following uv irradiation. (auth)

Radiation Effects Therapy and Countermeasures

3986 RADIOPROTECTIVE PROPERTIES OF CYSTEINETHIOSULPHONATE. T. W. Szczepkowski, T. Zebro, and J. Stachura (Krakow Medical School). Acta Biochim. Polon., 11: 235-40(1964).

The toxicity of cysteinethiosulfonate (CTS), a water-soluble analog of cystine, was determined and the protective effect of CTS against x irradiation was observed in mice. By injecting ^{35}S-CTS in mice, it was shown that mixed bisulfides are formed in vivo between blood serum proteins and the cysteine moiety of CTS. Lack of protective effect of cystine is probably due to its low solubility. (auth)

3987 THE EFFECT OF AET ON THE PERIPHERAL BLOOD CELLS OF THE RABBIT FOLLOWING GAMMA IRRADIATION. Norma V. Colclough (Children's Cancer Research Foundation, Boston) and Calvin Hanna. Arch. Intern. Pharmacodyn., 143: 8-16(May 1, 1963).

The marked radioprotective action of S,2-aminoethylisothiouronium bromide hydrobromide (AET) in rats and mice is achieved using large doses and the protective effect is dose related, but it is less effective in larger animals. It is possible that the radioprotective effect of AET is either species specific for the rodent (rat and mouse) or that this agent cannot be given in adequate doses to exert its radiation-protective action in larger animals. To study these possibilities the rabbit, which will tolerate intermediate doses of AET, was used to determine whether or not protection against radiation was afforded the hemopoietic system by this agent. When injected intraperitoneally in 200-mg/kg doses, AET was shown to exert a well-defined radioprotective action, or dose reduction factor, on the circulating peripheral white cells of the rabbit. It induced an increase in the total white blood count following 600 to 800 R doses of ^{60}Co γ irradiation. This increase was such that the recovery of the AET 800 R group was like that of the 600 R group, and the recovery of the AET 600 R group was earlier and greater in magnitude than the 600 R control group. AET alone and with irradiation produced a temporary marked increase in the circulating granulocytes occurring at one day. AET had no protective effect against the lethal action of irradiation as evidenced by lack of increased survival rate of rabbits pretreated with the drug. AET treatment before γ irradiation shows no evidence of having any effect on organ weight, or on total body weight when measured at the end of the 30-day test period. The radioprotection afforded by AET pretreatment on the hemopoietic system of the rabbit appeared to be intermediate between the protective action in the rat and in the dog. It did not modify the response of the hemopoietic system to the effects of radiation, but rather appeared to initiate faster recovery in the surviving cells. Whether the accelerated recovery of hemopoiesis, as indicated by the circulating peripheral blood cells, is evidence of greater survival of stem cells, of increased longevity of existing circulating cells, or of protection of a humoral factor controlling hemopoiesis was not revealed by the data obtained. (BBB)

3988 PRETREATMENT WITH AET BEFORE IRRADIATION TO MODIFY BONE MARROW TRANSPLANTATION IMMUNITY. K. Adachi, Sh. Hama, M. Yamagishi, H. Uchino, and G. Wakisaka (Kyoto Univ.). Bibliotheca Haematol., No. 19, 287-93(1964).

When Ha_2 and dd/s strain mice were used as the donors and recipients, respectively, in homologous bone marrow (HBM) transplantation, 14-day survival after 900-R γ irradiation was 20-50%, followed by a rapid increase in number of dying mice. Donor mice were irradiated with 100 or 500 R followed, within 2 hr, by injection of their bone marrow or spleen into lethally (900-R) irradiated recipient mice. The purpose of this experiment was to reduce antibody-forming ability of the donor. Initial survival was less than that in ordinary HBM treatment. Pretreatment with AET (S,2-aminoethylisothiouronium dihydrobromide) to the donor did not give good initial survival either. In another experiment, donor Na_2 mice were given 6 mg per mouse of AET and irradiated with 100 R of γ rays 10 to 15 min later. After 6 days, the treated Na_2 mice were sacrificed, the bone marrow was removed, and injected into the homologous recipient dd/s mice irradiated with 900 R of γ rays. When the number of nucleated cells given was 10 million, the survival rate was 83% and 67% at 30 days and 60 days, respectively. The same pretreatment to the isologous donor resulted in 100% survival in 60 days. Homologous bone marrow transplantation from Na_2 mice to 900-R irradiated dd/s mice usually gave 50 to 80% early death, which may indicate that bone marrow of Na_2 mice does not take easily in dd/s mice. When recipient mice were AET-pretreated and irradiated with 1500 R of γ rays, HBM seemed to take easily. This facilitation could not be observed with AET plus 1300-R irradiation. Increasing the dose of γ rays to 1800 and 2000 R resulted in acute intestinal death of most of the mice. (BBB)

3989 TREATMENT OF IRRADIATION SEQUELAE OF THE SKIN. H. Tritsch (Universität, Heidelberg). Chir. Praxis, 8: 129-38(1964).

Dermatological sequels of irradiation, especially late sequels, are often seen by the dermatologist. Usually such changes cannot be prevented since they are direct consequences of the therapeutic use of ionizing rays. Often the histopathological substrate consists of irreversible vascular changes that may lead to very painful ulcers with a low tendency to heal or no healing potential at all. Sequels of irradiation have a prognostic value, for they belong in the main to precancerous states, as in a number of cases they form the basis of a subsequent malignant tumor. Therapy is directed by knowledge of the physiopathology and significance of radiation sequels of the skin. Treatment of early changes mainly consists of indifferent external therapy. Treatment of late sequels can often be surgical only; sometimes tumor recurrences in the damaged skin area determine the methods of surgery. The main problem of dermatological surgery resides in the question of a suitable substitution for the skin in the damaged area. This should be decided prior to surgery, with consideration of various points of view. Eight patients with late radiation sequels are described to illustrate the various surgical possibilities of treatment. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3990 THE TREATMENT OF ACCIDENTALLY IRRADIATED PERSONS. G. Mathé (Hôpital Saint Louis, Paris). Clin. Radiol., 15: 14-29(1964).

Of 6 persons, accidentally irradiated in October 1959 by an experimental reactor at Vinca, Yugoslavia, 5 were believed to have received exposures ranging from LD_{50} to DA_{100}. By the 27th day post irradiation, it appeared that conventional symptomatic treatment would fail to prevent aplasia of bone marrow, and allogeneic bone marrow transfusion was given to the two men estimated to have received the heaviest exposures (1,000 to 1,200 rem and 700 to 1,000 rem, respectively). Six days later, similar treatment was given to two patients receiving exposures estimated at 600 to 1,000 rem, and on the 36th day post irradiation, the 5th accident victim, receiving an estimated dose of 600 to 800 rem, was given allogeneic bone marrow transfusion. All survived except the individual believed to have received the heaviest exposure. Death was caused by anuria complicated by intussusception of intestine a few days following bone marrow transfusion. In all 5 patients, there was evidence of restoration of myeloid tissue within a few days following bone marrow transfusion. The radiation response of the 5 accident patients was compared with that of 16 patients receiving 50 to 850 rads deliberate total body irradiation. It was concluded that hematological effects, histological lesions, clinical symptoms and decline in general health of the 5 accident victims were comparable or more severe than those of patients receiving 400 to 850 rads. The effect of allogeneic bone marrow transfusion was also measured in terms of mortality. Among 110 patients receiving deliberate total body irradiation for cancer, leukemia and renal transplants without bone marrow transfusions, mortality due to aplasia was 76.2% among 21 patients following 400 to 500 R., 93.3% among 15 patients following 500 to 700 R., 88.8% among 18 patients following 700 to 1,000 R., and 100% among 4 patients receiving more than 1,000 R. This is evidence in favor of the beneficial therapeutic effect of allogeneic bone marrow transfusion, and requires consideration of the mechanism of such effect. It is recommended that conventional symptomatic therapy such as aseptic conditions, platelet transfusion, antibiotics, be offered first. It is the failure of symptomatic treatment, and not the dose of radiation per se, that is the main indication for giving bone marrow transfusions. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3991 THE VALUE OF BONE MARROW TRANSPLANTATION FOR ACUTE ACCIDENTAL IRRADIATION INJURY. H. E. M. Kay (Roy Marsden Hospital, London). Clin. Radiol., 15: 41-3(1964).

Since the effects of marrow transplantation are not foreseeable, even when exposure is accurately known, it should be used when other procedures to accelerate recovery are unavailable, and under conditions which reduce risk. The author reviews clinical techniques and indicates that study of symptomatic treatment and histocompatibility relationships in man could make the effects more predictable. (Excerpta Med., Sect. XXIII, (Oct. 1964)).

3992 RELATIONS BETWEEN THE RADIOPROTECTIVE EFFECT OF CYSTEAMINE AND THE INHIBITOR EFFECT OF THIS SUBSTANCE ON OXYGEN CONSUMPTION BY AN EMBRYONAL ORGAN CULTIVATED IN VITRO. Jean-Michel Kirrmann (College de France, Paris and CNRS, Paris). Compt. Rend., 259: 2029-31(Sept. 21, 1964). (In French)

Cysteamine (0.016 to 0.064 M) protects the embryonic intestine of the chicken in organotypic culture against the early inhibition of the oxygen consumption observed on this organ after an irradiation of 7500 r. The radioprotective effect of cysteamine is exercised as well when this substance inhibits by itself the respiration of the cultivated intestine as when it does not inhibit. (tr-auth)

3993 ON THE TREATMENT OF RADIATION ULCERS WITH SALVE. H. Kleinert and K. H. Kaercher (Universität, Heidelberg). Med. Welt, No. 5, 259-61(Feb. 3, 1962). (In German)

Radiation ulcers often appear as late effects of treatment of tumors of the face and jaw, because in these areas the skin lies directly above the bone, the circulation is poorer than in other regions, and the skin tension impairs healing of the ulcer. Similar conditions are present along with radiation treatment of skin metastases from mammary cancer. Any substance that is used to treat postradiation ulcers must combine properties of disinfection, necrolysis, and stimulation of granulation tissue formation. A salve containing an oil-water emulsion of 15% dextrose, 0.2% allantoin, and 1.2% of the ethyl ester of linoleic acid was tested for its efficacy in treatment of postradiation ulcers. The salve base consists of cetiol and peanut oil. The dextrose and allantoin are dissolved in the aqueous phase, and the ethyl ester of linoleic acid is dissolved in the oil phase. Out of 20 cases where it was used for from 4 to 12 weeks, 11 showed a good response to the salve after radiation treatment. In 8 of the cases the results were only partially successful, and in one case the salve had no effect on healing of the ulcer. In cases where the ulceration is very extensive and involves destruction of deep tissues, the use of any salve will not result in restoration of the tissue, and surgical intervention will be required. However, in extensive ulcers use of the salve will reduce the inflammation and facilitate surgical procedures. Also, if the salve is

used for ulcers which develop soon after very high radiation doses have been administered, healing may follow without extensive scarification of the skin. (BBB)

3994 INFLUENCE OF HYPOTHERMIA ON THE RADIOPROTECTIVE EFFECTS OF β-MERCAPTOETHYLAMINE. E. Magdon (Robert-Rossle Klinik, Berlin). Nature, 204: 484-5(Oct. 31, 1964).

The radioprotective effects of MEA under conditions of hypothermia were studied in male mice given x-ray doses of 800 R. The protective effect of hypothermia alone was observed to be less than that of MEA alone. Neither did combination of hypothemia and MEA show potentiating or additive effects. Further, results suggested that in hypothermic conditioned hypoxic mice, the radioprotective effect of MEA was not evident. The fact that MEA was not effective in protecting mice when oxygen tension was lowered is explained by the assumption that MEA takes part in the oxygen-dependent production of free radicals. Hence it is assumed that MEA reacts with radioinduced radicals of biologically important molecules in competition with oxygen in such a way that the peroxidation of the radicals is prevented. (H.M.G.)

3995 PROBLEMS OF PROTECTION FROM RADIATION IN SPACE. A. Monti (Karolinska Sjukhuset, Stockholm). Notiz. Ric. Sci., 4: 209-14(1964).

Bombardment of the body by particles, especially solar protons and electrons from the outermost part of the Van Allen belt, constitutes a particular hazard to astronauts. Hypoxia may be a defence mechanism against these ionizing particles. This would agree with experiments carried out by Forssberg (Radiobiology Department, Stockholm) on the survival of rats subjected to total irradiation in conditions of hypoxia. The possibility of damage to the gonads by radiation may also be lessened by hypoxia. It is suggested that maintenance of some degree of hypoxia in the space cabin, in addition to lining the walls with lead, would be an advantage. (Excerpta Med., Sect. XXIII, (Oct. 1964))

3996 A CONTRIBUTION TO THE MECHANISM OF THE RADIOSENSITIZING EFFECT OF METAL BIOCATALYSTS. V. G. Yakovlev. Radiobiologiya, 4: 656-9 (1964). (In Russian)

A group of rats were given a harmless dose of 0.25 mg of Cu per 100 g of body weight, and were subjected to a ^{60}Co, γ dose of 400 R. The controls received no copper. The number of deaths was 5% in the rats receiving no copper, and 40% in the rats receiving an injection of copper prior to irradiation. On injecting cysteine (60 mg of the n-propyl ether, HCl addition salt per 100 g of body weight) along with the copper dose, the number of deaths in the irradiated rates (400 R) fell to zero. In this case copper acted as a specific catalyst for the oxidation of the sulfohydryl groups in cysteine which thus protects other important functional groups from irreversible oxidation by the radiation. (TTT)

3997 THE ROLE OF AUTOINFECTION IN THE DEVELOPMENT OF THE HEMORRHAGIC SYNDROME IN THE CASE OF ACUTE RADIATION SICKNESS. P. N. Kiselev, K. I. Nikitina, Shao-ch'ang Ch'eng, and Z. P. Karmanova (Inst. of Radiologic Scientific Research, Leningrad). Radiobiologiya, 4: 790-3(1964). (In Russian)

The outcome of acute radiation sickness depends on the development of 3 syndromes: pancytopenia, autoinfection and hemorrhagic phenomena. Therefore, the interaction of these factors was investigated on irradiated and unirradiated guinea pigs, using the E. coli endotoxin. The animals were killed at periods ranging from 1 to 15 days after exposure to 200 or 300 R of x radiation, and were subjected to bactereological examination, determining the bacteremia and estimating the hemorrhagic phenomena by visual observation. The results indicated that there is a definite correlation between autoinfection and hemorrhagic phenomena; the autoinfection precedes the development of the hemorrhagic syndrome. The gravity of the syndrome depends on the reproduction of microbes in the blood of the animals,- the autoinfection due to E. coli is one of the most important factors in this respect. By administering daily $1/_{60}$ to $1/_{200}$ of the mean lethal dose of the endotoxin of the intestinal bacillus, a hemorrhagic syndrome similar to that due to radiation sickness was observed. Introduction of this bacillus into irradiated animals was found to enhance markedly the hemorrhagic syndrome while delaying its reversal. (TTT)

3998 EFFECTS OF RADIOSENSITIZERS AND RADIOPROTECTORS ON THE RESPONSE OF CANCERS TO RADIOTHERAPY. J. R. Maisen (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.). Rev. Franc. Etudes Clin. Biol., 9: 437-55(Apr. 1964). (In French)

The association of substances increasing radiosensitivity or radioprotection with irradiation treatment has not, to date, achieved any results considered striking. This is due to the toxicity and nonspecificity of the drugs used. Of the substances increasing radiosensitivity certain antimetabolites (purine and pyrimidine bases) may offer some hope in the future. Of the radioprotector substances, some sulfhydryl compounds (AET and MEA) may be of therapeutic value either in preventive or curative irradiation of large body areas, or in high-dosage irradiation of smaller areas. These substances can only act palliatively or as an adjuvant to preventive treatment. A synergism appeared to exist between the effects of x rays and ribonuclease. (auth)

3999 CHEMICAL AND BIOLOGICAL RADIATION PROTECTION. R. Koch and H.-J. Melching (Universität, Freiburg i. B.). Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 25, 145-69(1963). (In German)

A literature survey was made on German studies of chemical and biological radiation protection. Protective effects of sulfhydryl compounds, amines, and other compounds are discussed. Radiation protection by organ transplantation or extirpation and by organ homogenates or lysates is reported. (207 references). (M.C.G.)

4000 PROTECTIVE EFFECTS OF STREPTOMYCIN AGAINST RADIATION INJURIES OF GONAD CELLS IN MAMMALS. Shao Wei, Tu-Kung Wang, and Hang Chang. Sci. Sinica (Peking), 13: 1523-5(Sept. 1964). (In Russian)

It was established earlier that low concentrations of antibiotics, specifically streptomycin, exert a protective action against radiation injury to the chromosomes, while high concentrations enhance the damaging effect. The problem was further studied by determining the chromosome aberrations in the gonad cells of white mice. The animals were treated 8 hours before exposure to 150 R with various amounts of streptomycin sulfate, dissolved in physiological solution. The radiation alone caused 10.4 and 9.18% of chromosome aberrations in the gonad cells 16 and 38 hours, respectively, after exposure, instead of the 0.13% in the unirradiated animals. Introduction of 0.5 or 1.0 mg of streptomycin lowered markedly the frequency of the chromosome aberrations in about 50% of the cases, but administration of 3 to 5 mg of the agent revealed no protective action. On the other hand, introduction of streptomycin without exposure to radiation did not affect the frequency of the aberrations. The protective action is probably due to the guanidine group in the compound. (TTT)

4001 MODIFICATION OF THE EFFECT OF WHOLE-BODY RADIATION BY THE ORAL ADMINISTRATION OF NONABSORBABLE ANTIBIOTIC. Chester B. Rosoff (Beth Israel Hospital, Boston). Surg. Forum, 13: 43-5(1962).

A study was made of the effect of control of the intestinal flora on the lethality of radiation damage. Female Wistar rats, 6 to 8 weeks of age and differing only in their intestinal bacterial flora, were exposed to 550 R whole-body x radiation delivered in a single dose. Control and experimental groups were irradiated and housed together. The control group was shown to bear the usual pattern of intestinal bacteria with Escherichia coli predominating, but including enterococci, Proteus vulgaris, E. freundii, Pseudomonas aeruginosa, and others. The experimental groups were given neomycin in solution by gavage. This resulted in a sharp reduction in the numbers of enteric organisms. The control group (rats with normal intestinal flora) developed diarrhea on the third day after irradiation. This was promptly followed by lassitude and bleeding from the nose. A marked reduction in water and food ingestion occurred, associated with a progressive loss of up to 25 to

30% body weight. Mortality was 100% with survival averaging 11.7 ± 2.85 days. In coliform-free rats which were each given 10 mg of neomycin by gavage for three days prior to radiation exposure and throughout the 30-day observation period thereafter, no diarrhea or bleeding was noted and they remained normally active and clinically well. An initial loss of 8 to 10% of body weight was noted in the first 5 days. There was no mortality in this group. In coliform-free rats started on neomycin, 25 mg daily by gavage at varying intervals after radiation exposure, none developed the debilitating diarrhea seen in the controls, but mortality increased rapidly with delay in treatment. There were no deaths during the 30-day observation period in the group treated within one hr after irradiation, but, after a two-hr delay, 20% mortality was observed; after four hr, 40%; after 8 hr, 55%; and after 24 hr had elapsed, 95% succumbed. Whenever stool cultures continued to show coliform organisms despite neomycin therapy, death of the animal was invariable, irrespective of the time relation between treatment and radiation. This correlation between survival and effectiveness of the antibiotic was valid when neomycin was begun prior to or immediately after irradiation, but thereafter delay was equated with mortality despite the subsequent change to negative stool cultures. Thus, there is evidence that bacterial products absorbed from the intestine account for the rapidly lethal effect of whole-body radiation and that nonabsorbable antibiotic is protective when started before or immediately after this degree of radiation exposure. (BBB)

4002 EFFECT OF SPLEEN HOMOTRANSPLANTS IN ANIMALS SUBJECTED TO SUBLETHAL DOSES OF TOTAL-BODY IRRADIATION. W. Guy Fiscus, John J. Trentin, Vincent P. Collins, Dwain G. Fuller, and George L. Jordan, Jr. (Baylor Univ., Houston, Tex.). Surg. Forum, 14: 182-4(1963).

Experimental homografts of immunologically competent tissue to immunologically unresponsive hosts may produce homologous disease, characterized by marked body weight loss, severe hemolytic anemia, lymphoid aplasia, and mortality. To investigate the possibility of producing this type of reaction in dogs, splenic homotransplants were performed following sublethal doses of whole-body irradiation. Irradiation was conducted with the 2-Mev Van de Graaff generator on animals divided into 3 groups: 300 R, whole-body irradiation only; 300 R whole-body irradiation plus spleen autograft; and 300 R whole-body irradiation plus spleen homograft. In the second group, irradiation was done subsequent to grafting, with the spleen exteriorized and shielded. The mortality rate within 10 days postoperatively was 86% among Group 3 dogs (with homografts) and 40% among Group 2 dogs (with autografts). Only 17% Group 1 dogs, controls with irradiation only, died. Group 3 manifested a greater drop in hematocrit level than either control group of animals. All Group 3 dogs that died manifested hemolysis; less severe hemolysis was observed in a few Group 2 controls. Platelet count was severely depressed in all groups, but dropped earlier in the Group 3 and returned toward normal values in this group later than in Group 2. The average platelet count in Group 3 between days 4 and 10 was 45,000, compared with 99,000 in Group 2. The blood leukocyte count was depressed about equally in Group 1 and Group 3. In Group 2, however, it was depressed later and returned more quickly than in the other groups. The peripheral blood lymphocyte count was severely depressed in all groups within two days after irradiation. Between days two and five there was more depression in Group 3. Body weight was depressed in the groups which had been operated upon, as compared with the controls with irradiation only. The primary histopathologic features included severe lymphoid destruction in all groups following irradiation, marked hyperplasia in cells in thymus and lymph nodes of animals with homografts, erythrophagocytosis in the nonsplenic lymphoid tissue of the dogs with homografts, and splenic necrosis in both groups receiving transplants. These histopathologic observations indicate that the dose of irradiation used severely affected the host lymphoid tissue morphology and, hence, presumably its immunologic competence. This should increase the likelihood of a reaction of the grafted unirradiated foreign spleen against the host. The findings of erythrophagocytosis and large cell hyperplasia in the dogs with homografts are compatible with graft vs host immune reactivity. (BBB)

4003 EFFECTS OF CELL-FREE EXTRACTS OF THYMUS IN LEUCOPENIC RATS. J. G. Camblin and J. B. Bridges (Queen's Univ., Belfast). Transplantation, 2: 785-7(Nov. 1964).

Newborn rats were exposed to doses of 1000 R x radiation over the thymus and 100 R whole-body x radiation within 24 hr of birth. This treatment resulted in sustained leukopenia with a maximum about 10 days after exposure and a white blood cell count about 40% of normal 30 days after irradiation. Treatment with cell-free extracts prepared from the thymuses of 2-month-old rats 8 days after irradiation caused the white blood cell count to rise from 3,500 to 5,600/mm^3 by the 5th day and to reach approximately normal levels by the 26th day. Rabbit thymus produced marked lymphocytosis after several days but saline, boiled rat thymus extract, and rat brain and spleen extracts produced no significant elevation in the white cell count of irradiated animals. (C.H.)

4004 TUBERCULOSIS OF THE RAT AFTER LETHAL X RADIATION (800 R) AND SUBSEQUENT HETEROLOGOUS BONE MARROW AND SPLEEN CELL TRANSPLANTATION FROM GUINEA PIGS. E. Gabler and O. Pendl (Wilhelminenspitals der Stadt, Vienna). Wien. Z. Inn. Med. [Grenzg.], 44: 129-37(Mar. 1963). (In German)

Ten adult albino rats received 800 R of whole-body x radiation, given over a period of 19 min. Fifteen min later the irradiated animals received an intraperitoneal injection of ~45 g of spleen cells obtained from guinea pigs. The same amount of a bone marrow suspension, obtained from the four long bones (humerus and femurs) of the same guinea pigs was given intraperitoneally 30 min after the radiation. The animals were tested with tuberculin and found negative, and parenchymatous organs, such as spleen, liver, lungs, and kidneys, were examined for tubercular foci so that presence of the disease could be excluded. Over 50% of the animals survived for 100 days. The animals that survived for at least 60 days were injected subcutaneously with 1 mg of tubercule bacilli of the human type. On the same day 10 unirradiated albino rats and guinea pigs were injected with the same amount of tubercule bacilli. Six weeks after the injections of bacilli all of the animals were killed. Sections of the parenchymatous organs were prepared. The transfused animals had lived for 3.5 months after irradiation and were in the same general state of health as the control animals. The transfused animals retained their species-specific resistance to tuberculosis, as shown by the retention of the tubercule bacilli in macrophages and lack of changes in the reaction to the guinea pigs marrow cell infusions. The control guinea pigs that were injected at the same time showed severe tuberculosis. The control rats, that received the tubercule bacilli and were killed at the same time as the transfused animals did not show any gross or microscopic differences from the irradiated animals. The resistance of the rats to 800-R irradiation was not altered after heterologous bone marrow and spleen cell transfusions. There was no allergic reaction induced by the infusion after the lethal dose of radiation. (BBB)

4005 VOPROSY PATOGENEZA, EKSPERIMENTAL'NOI TERAPII I PROFILAKTIKI LUCHEVOI BOLEZNI. (Problems in the Pathogenesis, Experimental Therapy and Prophylaxis of Radiation Sickness). P. D. Gorizontov, ed. Moscow, Medgiz, 1960. 432p.

A collection of 25 papers on the pathogenesis, experimental therapy, and prophylaxis of radiation sickness is presented. Over 700 references are included. (IIC-M.G.)

Radiation Hazards and Protection

4006 (EUR-1835.f) RECHERCHES SUR LES EFFETS MULTIPLES DE CERTAINS RADIOPROTECTEURS CHIM-

IQUES. ANNEES 1962-1963. (Researches Performed on the Effects of Certain Chemical Radioprotectors — Years 1962-1963). (Liège. Université). 1964. Contract 006-61-12BIOB. 15p. Dep.(mn).

Results are summarized from studies of the biochemical, pharmacological, and cytological effects of cysteamine and its main metabolites and of cystamine on various animal systems, including mouse ascites tumor, isolated frog heart, mouse hair, chicken embryo, cat nictitating membrane, the effects of cysteamine on different enzymatic systems in vitro, on bile components, and on hepatic mitochondria; and the effects of various radioprotectors on E. coli and on the growth of barley seedlings. It was concluded that the radioprotective effect of cysteamine and related substances is not due entirely to cellular anoxia. (C.H.)

4007 HEPATIC CHANGES INDUCED BY AN AQUEOUS EXTRACT OF ULTRAVIOLET-IRRADIATION LINOLENIC ACID. Vaman S. Waravdekar, Leonard D. Saslaw, and Wallace A. Jones (Armed Forces Inst. of Pathology and Veterans Administration Central Lab. for Anatomic Pathology and Research, AFIP, Washington, D. C.). Am. J. Pathol., 45: 889-903(Dec. 1964).

Aqueous extracts prepared from ultraviolet-irradiated linolenic acid contain materials toxic to mice. Eight days after 2 intraperitoneal injections of the extract at the LD_{25} level, the margins of the 2 major lobes of the liver begin to swell. After 20 days the margins are quite swollen, and by 30 days the lobes are fused. Within 2 days after injection the extract induces focal necrosis of hepatic parenchymal cells and capsular inflammation appears. Regeneration is apparent after 7 days, at which time cellular necrosis is not encountered. The livers ultimately exhibit hyperplasia, and at a time when the lobes are swollen the capsule appears inflamed and thickened. In livers with fused capsules the septum separating the two lobes becomes thin and discontinuous with disruption of collagen, reticulin and elastic fibers. The protein content in the livers is increased by 20 to 30 per cent over that of controls 30 and 50 days after administration of the extract. The administration of an aqueous extract from nonirradiated linolenic acid failed to induce such changes. (auth)

4008 A METHOD FOR CALCULATION OF THE ABSORBED DOSE TO THE EPITHELIUM OF THE RESPIRATORY TRACT AFTER INHALATION OF DAUGHTER PRODUCTS OF RADON. J. Thomas (Inst. of Industrial Hygiene and Occupational Diseases, Prague). Ann. Occupational Hyg., 7: 271-84(Sept. 1964).

A method is described for the calculation of the absorbed α radiation dose to the epithelium of the respiratory tract after inhalation of aerosols containing daughter products of radon or ion components of radon daughters. The method is based on a model for anatomical and histological structure of the respiratory tract and physiological processes taking place in it. Summation of the processes of deposition, elimination, and successive transmutation of the inhaled radioactivity in different regions was carried out by the system of linear partial differential equations for the regional surface activity with corresponding initial and boundary conditions. (C.H.)

4009 RADIATION PROTECTION IN CANADA. H. E. Duggan. Can. Med. Assoc. J., 91: 893-9(Oct. 24, 1964).

Factors that may reduce the dose of radiation, from diagnostic and therapeutic x-ray procedures, to the patient and to the occupational and non-occupational worker are outlined. Suitable basic radiation measuring apparatus is described. It is recommended that, in diagnostic radiography, relatively high kilovoltage, proper cones, collimation, and adequate filtration be used. Some specific recommendations are made concerning fluoroscopic, photoroentgen, and portable x-ray examinations. Film monitoring of personnel is advisable. Examples are given of protective devices to lessen the dosage to the occupational worker. It is the responsibility of the radiologist or physician in charge to ensure that the x-ray equipment is safe to operate and the radiation dose to the patient is kept to a minimum. The roentgen output for all radiographic examinations should be known by the responsible user. (auth)

4010 NEW APPROACH TO RELATIVE BIOLOGICAL EFFECTIVENESS. G. Silini (CNEN, Rome). Comit. Nazl. Energia Nucl., Notiziario, 10: No. 2, 25-8(1964).

A report is presented and commented upon released by the international committee charged in 1960 by ICRU and ICRP to study the concept and the use of relative biological effectiveness with special regard to problems of protection against radiation. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4011 ESTIMATION OF LUNG TISSUE DOSE FROM THE INHALATION OF RADON AND DAUGHTERS. B. Altshuler, N. Nelson, and M. Kuschner (New York Univ., New York). Health Phys., 10: 1137-61(Dec. 1964).

The radon hazard is presumed to be lung cancer induced by alpha irradiation of basal cells in the bronchial epithelium. The effective dose was calculated by a relatively complete analysis that includes the distribution of atmospheric activity by size and daughter, the prediction of alpha decay in the bronchial regions from a model of mucus flow superimposed on calculated regional deposition, measurements of epithelial thickness to determine accessibility of basal cells, and classification of dose by inhaled daughter, size, alpha particle, region, and tissue depth. The cancer-related dose, taken as the largest dose to exceptionally shallow basal cells, associated with one working level of radon daughters was estimated to be 20 Rads/yr for nose breathing at 15 l/min, and it may be higher. Comparison with animal experiments suggests that the working level may not be safe and that 30 pC/l of daughters (0.1 WL) may not be too conservative for the MPC. (auth)

4012 THE DOSE TO THE HUMAN RESPIRATORY TRACT BY INHALATION OF SHORT-LIVED ^{222}Rn- AND ^{220}Rn-DECAY PRODUCTS. W. Jacobi (Hahn-Meitner-Institut für Kernforschung, Berlin). Health Phys., 10: 1163-74 (Dec. 1964).

The deposition of Rn daughters in the different regions of the human respiratory tract was derived from the particle size of their carrier aerosol in ordinary, unfiltered air. The resulting mean distribution of the radioactivity in the respiratory tract was estimated, taking into account the clearance from the alveolar tissue and the ciliary transport in the bronchial tree. The radiation dose distribution in the epithelium of trachea and bronchi was calculated, taking into account the α-absorption in the mucus layer and the variation of stopping power with α-energy. The resulting mean absolute α-dose in different regions of the respiratory tract is given for each inhaled nuclide, especially at their natural level in atmospheric air and their maximum permissible level. The results indicate, that owing to the ciliary transport, a considerable fraction of the dose in the upper respiratory tract is due to the transfer of activity from the bronchioli and lower bronchi in the mucus stream. The highest dose should be expected in the lower bronchi. (auth)

4013 EMPIRICAL ESTABLISHMENT OF CANCER—ASSOCIATED DOSE TO THE LUNG FROM ^{144}Ce. Herman Cember (Univ. of Cincinnati). Health Phys., 10: 1177-80 (Dec. 1964).

Cerium-144, either as the chloride or as the fluoride, was intratracheally injected into rats at dose levels that ranged from 0.5 to 50 μC. In the case of both substances, the radiocerium was deposited in the lungs as discrete focii of radiation. Lung cancer was found at every treatment level. Among 395 rats so treated that survived for 30 days or longer, a total of 101 malignant neoplasms was found. On the basis of pulmonary clearance studies, the organ mean radiation dose that had been absorbed by the lung, from the radioactive particulates, during the survival time of each rat was calculated. The cumulative tumor frequency, when plotted against the logarithm of the organ mean dose, resulted in the lower half of an ogive-shaped dose-response curve. (auth)

4014 PULMONARY FUNCTION OF URANIUM MINERS. V. E. Archer (Occupational Health and National Cancer Inst., Salt Lake City), H. P. Brinton, and J. K. Wagoner. Health Phys., 10: 1183-94(Dec. 1964).

Analysis was made of several ventilatory function field

measurements made on uranium miners in 1957 and in 1960. Results show that cumulative exposure to the atmosphere in uranium mines adds to the loss in ventilatory function which results from aging and from cigaret smoking. The data indicate that high radon daughter levels are associated with transient improvement in ventilatory function. Two possible explanations of this transient improvement are discussed. Long exposures within uranium mines are definitely detrimental to ventilatory function. (auth)

4015 LUNG CANCER OF URANIUM MINERS ON THE COLORADO PLATEAU. G. Saccomanno, V. E. Archer, R. P. Saunders, Lynn A. James, and Patricia A. Beckler (St. Mary's Hospital, Grand Junction, Colo.; Veterans Administration Hospitals, Grand Junction, Colo.; and Public Health Service, Salt Lake City, Utah). Health Phys., 10: 1195-1201(Dec. 1964).

Men with cancer of the lung found during a 16-yr period were analyzed. The cases were collected in an area covering 15 counties, embracing the uranium industry in Western Colorado and Eastern Utah. Comparison of the tumor cell types revealed the uranium miners to have a high proportion (57%) of the undifferentiated variety of tumors; 76% of these were of the oat cell type. The comparison group, matched for age and smoking, had only 18% of the undifferentiated cell type tumors. Only 37% of the lung tumors of the uranium miners were of the epidermoid variety in contrast to 62% for the control group. The difference in cell type cannot be attributed to cigarets or age. Differences in survival time, symptoms, and tumor location were also noted. (auth)

4016 DETERMINATION OF ^{32}P IN BIOLOGICAL SAMPLES IN RELATION TO THE MAXIMUM PERMISSIBLE DOSE FOR INTERNAL IRRADIATION IN MAN. S. Todisco, A. Franceschini, C. Gandolfi, and E. Rapetti (SORIN, Saluggia, Italy). Minerva Nucl., 8: 278-81(Sept.-Oct. 1964). (In Italian)

The use of ^{32}P in radiobiological laboratories mainly entails the risk of contamination of the personnel handling the isotope and of the waste fluids discharged from the laboratory. In order to assess this risk, periodical examinations were made both of urine samples from the personnel and of fish from the river into which the waste products of the laboratory are discharged (Dora Baltea). From an analysis of the data reported in the literature and from a number of assumptions suggested by the possibility of contamination of the food, the maximum permissible doses for the specific activity of ^{32}P were calculated for the urine and for fish. The methods of analysis used are described and their ranges of sensitivity and exactness are presented. (auth)

4017 RADIATION EXPOSURE FROM THE USE OF RADIOIODINE IN THYROID DISEASE. E. Eric Pochin (London Univ.). Proc. Roy. Soc. Med., 57: 565-5(July 1964).

An estimate of the genetically significant exposure of the population to radioiodine is given and it indicates that the use of this isotope in thyroid disease contributes only about 0.6% of the total exposure from medical radiology (0.11 of a total of 19.3 mrad/yr). In the individual, thyroid irradiation will normally not exceed 10 Rad when 5-μC test doses of ^{131}I are given to adults, but exposure five to ten times higher could occur in the glands of infants or fetuses, or in tests on nongoitrous children. In such cases the thyroid exposure can normally be reduced to below 1 Rad by using 5-μC doses of ^{132}I if the necessary diagnostic information is obtainable by measurements that can be made during the first few hours after administration of this short-lived form of radioiodine. Radiation exposures of the gonads, the marrow, and the body tissues generally are much less than those of the thyroid, by a factor of ~100 in the case of ^{132}I and of several hundreds for ^{131}I. In the radioiodine therapy of hyperthyroidism, the mean dose to blood is likely to be between 15 and 20 Rad, although substantially higher doses may occur in some patients. Despite the treatment of large numbers of patients, no evidence has been obtained of any excess incidence of leukemia above that which would be expected by chance. In the radioiodine therapy of thyroid cancer, a significant induction of leukemia is recognized. The limited total number (15) of all such cases that appear to have been reported suggests that this incidence (2.3% or 13 cases per million patient-yr-rad) may substantially overestimate the average risk of this occurrence, and the risk does not appear to be so high as to contraindicate the use of a form of therapy that is valuable in the control of disseminated malignancy. (TCO)

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4018 (AED-C-10-02) NUCLEAR MEDICINE. BIBLIOGRAPHIES. Radionuclides in Clinical and Experimental Oncology. (Berlin. Freie Universität). Sept. 1964. 81p. Dep.(mn).

The references are arranged into sections dealing with tumor therapy and diagnosis, metabolism of tumors, experimental tumors, carcinogens in animals and humans, labeled carcinogens, labeled chemical therapeutics, etc. An author index is included. (D.L.C.)

4019 COMBINED THERAPY WITH 220 KV ROENTGEN AND 10 CM MICROWAVE HEATING IN RAT HEPATOMA. Donald B. Cater, Ian A. Silver, and D. Anne Watkinson (Cambridge Univ., Eng.). Acta Radiol. Therapy, Phys., Biol. (N.S.), 2: 321-36(Oct. 1964).

Combined therapy with 2,620 R of 220 kv roentgen rays and subsequent 10 cm microwave heating of tumor to 47°C for 8 to 10 min. cured some rats with hepatoma-223 transplanted in the leg. In rats treated by radiation alone, or diathermy alone, there were no long-term survivors, the mean tumor size was greater, and the mean survival time was significantly shorter, than in rats treated by the combined therapy. (auth)

4020 EFFECT OF HIGH ENERGY PROTONS ON HUMAN GENITAL CARCINOMA. B. Fors, B. Larsson, A. A. Lindell, J. Naeslund, and S. Sténson (Uppsala Univ.). Acta Radiol. Therapy, Phys., Biol. (N.S.), 2: 384-98(Oct. 1964).

Ten cases of advanced cervical carcinoma treated with proton irradiation are described in detail. All the tumors regressed macroscopically and regression was evident microscopically in almost all the biopsy specimens. One patient is alive and without recurrence 21 months after irradiation. No growth was evident at autopsy in two patients. (auth)

4021 RADIOPULMONOGRAPHY: A METHOD FOR SIMULTANEOUS ESTIMATION OF REGIONAL LUNG VENTILATION BY TRANSMISSION OF X RAYS. M. J. Small, W. N. Miller, G. C. Leiner, H. D. Strauss, and S. Abramowitz (Veterans Administration Hospital, East Orange, N. J.). Am. Rev. Respirat. Diseases, 90: 223-30(Aug. 1964).

A method is presented that utilizes the passage of x rays through the chest and measures the exit beam. Respiration alters the linear density of the lung tissue and thereby alters the intensity of the exit beam. Inspiration decreases the linear density and increases the exit dose. These intensity changes, recorded over time, result in characteristic curves that are distorted in the presence of pulmonary disease. The system is set up and calibrated by centering the x-ray tube with reference to the detector probes and checking for equal response of the two channels when the x-ray beam is turned on. The subject is then seated with the probes applied to corresponding areas of each lung. The x-ray source operating at about 30 kv and less than 0.5 ma, with 2-mm aluminum filter, is placed 6 ft from the patient. The average output measured 58 mR/hr for a maximum of 360 mR/hr, depending upon the milliamperage dial setting, which is varied depending upon the thickness of the chest or the density of the lesion. Based on an average exposure of 10 min, it is calculated that the patient would receive a maximum of 10 to 60 mR on the most exposed side and a smaller fraction on the exit side. This is less than the exposure necessary for a single chest film with intensifying screens. Radiopulmonography, which is

completely painless and harmless, permits study of a small portion of the lung, whereas bronchospirometry estimates ventilation of each lung as a whole. Results obtained with this method in normal subjects and in patients with pulmonary diseases are presented. It is suggested that further use of this method might contribute to a better understanding of pulmonary pathophysiology and that, with further refinements in technique and standardization, it might be possible to estimate quantitatively the ventilatory function of localized lung areas. (BBB)

4022 NEW METHOD OF INVESTIGATION OF THE PERIPHERAL CIRCULATION, USING I^{131}. A. Bucur, I. Făgărăsanu, V. Bratu, and M. Vosnesenschi (Carol Davila Hospital, Bucharest). Bull. Soc. Intern. Chir., 23: 95-104 (1964).

A new method of assessing the rate of removal of metabolites from the peripheral circulation is described, using radioiodine, an effort test, and novocaine block of the lumbar sympathetic chain. This method facilitates the study of changes in the peripheral circulation which are vasomotor in origin, so that cases which will respond to sympathectomy or vasodilator drugs may be selected. The authors regard the method as useful both for diagnostic precision and for predicting the therapeutic results of treatment. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4023 GLASS RADIOGRAPHY: A SIMPLE SLIDE-TEST FOR CONTROL OF RADIATION SOURCES WITH HIGHER DOSE INTENSITY. W. Born (Universität, Freiburg i. B.). Hautartzt, 13: 512-15(Nov. 1962). (In German)

Ionizing radiation darkens photographic emulsions, as well as other organic and inorganic materials. Some of these color changes are proportional enough to the radiation dose to be usable in dosimetry. At the higher dose rates from x ray, or β and γ rays the degree of darkening of glass is proportional to the dose rate of the source. If the radiating surface of a flat metallic $^{90}Sr-^{90}Y$ applicator, providing a dose rate of 100 to 1000 r/min, is placed directly onto an ordinary glass slide for a period of 24 hr, the glass will be discolored in grey-brown shades that are proportional to the activity of the source. The differences are more pronounced after 48-hr exposure of the slide. During the first few hr after the exposure the degree of darkening decreases rapidly, but at room temperatures and over a period of several months subsequent to this it decreases relatively little. With longer exposure periods the discoloration intensifies, but as the exposure times is increased more, the degree of increase in optical density falls until finally a saturation value is reached. Whether there might be a clearing analogous to the solarization effect seen with photomaterials, when the glass is exposed to sources of very high radiation intensity for periods of many months beyond this, was not determined. The patterns of darkening obtained on the glass slides can be compared by the usual radiographic or autoradiographic methods. The procedures are denoted as glass radiography or glass autoradiography. Compared to film, which darkens considerably at rather low intensities, glass radiography has the advantage that at very high dose intensities it is less sensitive by several orders of magnitude. Securing exact exposure contact within fractions of seconds to avoid excessive exposure is as serious a difficulty as film losses from improper exposure. Material expenditure itself is much less than with the use of films, since slides are usually very generally available. These procedures outlined here will require development in the same manner as those of film exposure methods. (BBB)

4024 LUNG PHOTOSCANS WITH MACROAGGREGATES OF HUMAN SERUM RADIOALBUMIN. EXPERIMENTAL BASIS AND INITIAL CLINICAL TRIALS. G. V. Taplin, D. E. Johnson, E. K. Dore, and H. S. Kaplan (Univ. of California, Los Angeles and Los Angeles County Harbor General Hospital, Torrance, Calif.). Health Phys., 10: 1219-27(Dec. 1964). (UCLA-12-521)

A method for preparing a metabolizable, a particulate test material that is safe to inject intravenously, namely 5–25 μ macro-radioalbumin aggregates (MRAA), is described. Experimental evidence in animals ensures a tremendous factor of safety (~1000-fold) for injecting the minute quantities needed for scanning. Experience from scanning more than 100 patients verified the safety and revealed the diagnostic value of the procedure. It has the unique capacity to detect regional pulmonary ischemia caused by emboli and other diseases which obstruct pulmonary arterial blood flow before signs of these lesions are recognizable in routine chest x-ray films. (P.C.H.)

4025 NEW RADIOGRAPHIC AND ISOTOPIC PROCEDURES IN NEUROLOGICAL DIAGNOSIS. G. Di Chiro (National Inst. of Health, Bethesda, Md.). J. Am. Med. Assoc., 188: 524-9(1964).

A recently introduced refinement of pneumoencephalography (axial transverse encephalography) allows the brain to be seen in a new plane, as looking down from above. A new tracer for radioactive brain scanning, radioiodinated antifibrinogen (RIAF), shows promise for localization of certain lesions. Radioiodinated serum albumin (RISA) has been injected directly into the ventricles (radioiodinated serum albumin ventriculography) and intrathecally (radioiodinated serum albumin cisternography) to offer a new approach to brain scanning. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4026 SELECTIVE ISOTOPIC LABELING OF THE HUMAN PARATHYROID: A PRELIMINARY CASE REPORT. E. James Potchen and D. Bruce Sodee (Peter Bent Brigham Hospital, Boston and Walter Reed General Hospital, Washington, D. C.). J. Clin. Endocrinol. and Metab., 24: 1125-8(Nov. 1964).

The location of a hyperactive parathyroid gland was demonstrated preoperatively by means of isotopic labeling and external photoscanning. This was accomplished with the use of gamma-emitting ^{75}Se selenomethionine as an amino acid precursor of parathyroid protein. Preliminary suppression of thyroid protein anabolism, to diminish regional radioactivity interference was achieved by triiodothyronine administration. The potential clinical implications of this initial and successful localization of the parathyroid gland by the use of a radioisotope are considered. (auth)

4027 PLASTIC REPAIR OF THORACIC WALL DEFECTS AFTER RESECTION OF MAMMARY CARCINOMA RECURRENCES AND RADIATION INJURIES. H. Bruck. Klin. Med. (Vienna), 17: 295-9(Apr. 1962). (In German)

The procedures outlined here provide an operative basis from which to repair thoracic wall injuries which may appear many years after radical surgery for mammary carcinoma, when the entire thoracic wall must be removed. One of the most important reasons for this operation is the tissue destruction caused by x ray treatment, which extends throughout the ribs and eventually involves the pleura. This may be induced either by x ray injury or by radiation carcinoma. Another reason for the operation described here is the apperance of local carcinomas in the thoracic wall, provided they are localized and are not metastases from another area. It is a well-known fact that local recurrences in the thin skin covering that remains after massive breast removal can grow very rapidly and infiltrate the ribs and intercostal spaces. Differential diagnosis of these two types of tumors can only be ascertained with certainty histologically. Radiation injuries of the skin surrounding the tumor do not specifically indicate an x ray carcinoma, because there are local recurrences even with x ray ulcers, and also radiation injuries can appear even in skin that has been only slightly damaged. Generally, the prognosis for radiation injuries is much more favorable than for genuine local recurrences of the tumor. (BBB)

4028 IMPROVED METHOD OF THYROID SCANNING WITH EKCO GAMMA CAMERA. John A. Thomson, James A. Boyle, Donald R. G. Tilston, and R. G. David (Royal Infirmary, Glasgow). Lancet, 2: 73-4(July 11, 1964).

A new instrument is described to be used for scanning the thyroid gland to determine the distribution of accumulated radioiodine. The device consists of a pinhole camera incorporating a scintillation crystal in place of the photographic film and utilizing γ rays instead of light. The emissions from the crystal are collected by photomultipher

tubes, and the pattern of radioactivity is displayed on a fluorescent screen. A photograph is taken by a Polaroid camera to give an immediate and permanent record. To facilitate precise correlation of this record with the patient's neck region a double-exposure photograph is taken of the patient's neck after photographing the display on the fluorescent screen. Because the image on the fluorescent screen does not bear a 1 : 1 relation to the size of the thyroid gland, the Polaroid camera has to be operated farther away from the neck than the gamma camera. The gamma scan of a patient is shown. With an oral dose of 24 μC of ^{131}I the whole procedure takes ~five min. (TCO)

4029 RADIATION DOSE AND COSMETIC EFFECT IN TREATMENT OF HEMANGIOMA DURING THE FIRST THREE YEARS OF LIFE. Karlheinz Renner and Helga Hallerbach. Med. Welt, 52: 2758-61(Dec. 29, 1962). (In German)

From experience with 1439 hemangiomas in patients of from 3 to 36 months of age treated over a period of 15 yr about half were removed without visible radioinduced changes of the skin. In treatment of hemangiomas the age of the patient, the size of the hemangioma, the area of localization, the morphological differentiation of the hemangioma, and the type of radiation to be used are often not considered adequately or compared to the radiation dose level to be used. The younger the patient the more radiosensitive they were. Relatively lower doses were effective for hemangiomas in the inner aspect of the hand and the sole of the foot. The highest doses were needed for tumorous hemangiomas of the scalp and facial region. The radiation doses administered must be fractionated to prevent injury and to obtain a good cosmetic effect. Small doses of 100 R or less are ineffective. Doses from 150 to 200 R daily are the most effective. With sources, such as ^{90}Sr, that have very short tissue absorption paths, the single dose for weekly fractionation can be increased from 500 to 1000 rep to from 2000 to 3000 rep, depending on the size of the field. Radiation series of 600 R can be used when there is evidence of spontaneous healing, with 3- to 6-month waiting periods between the second and third radiation series of 200 to 600 R per series. The total length of treatment may extend to as long as 18 months. For a field with a diam of 3 cm the dose required is 30% greater than for a field size of 1 cm; when the area of the field exceeds 12 cm^2, the dose must be reduced by 30% to avoid skin injuries. Compared to the dose that can be administered with 50-kv x rays a dose three times as great can be given with 10-kv grenz rays, and β radiation from ^{90}Sr can be doubled. The choice of the type of radiation is determined by its tissue absorption, and radiation sensitivity of tissues such as gonads, bone, dental tissue, eyes, etc. In tangentially focused fields the relative depth dose is difficult to estimate, because small differences in the incident angle and variations in the skin-focus distance can produce large differences in the summation of the depth dose. Decreasing the depth dose by use of tangential fields produces less satisfactory results than increased fractionation and fewer half value layers. (BBB)

4030 INFREQUENT SECONDARY SIDE-EFFECTS OF I^{131} THERAPY OF HYPERTHYROIDISM OBSERVED IN 3500 CASES. L. Gennarelli and R. Lenti. Minerva Med., 55: 397-8(1964).

Because of very rare, early or late complications, radioiodine treatment (^{131}I) is the best therapeutic weapon against hyperthyroidism available today, being certain in its results, convenient to carry out, and free of side-effects. The authors could reaffirm this on the basis of experiences in Basedow's disease, thyrotoxicosis, and hyperthyroidism resistant to the usual treatment, and taking into account that in a large case material from the Mayo Clinic the incidence of myxoedema following partial thyroidectomy for exophthalmic goiter amounted to 10%. Hyperthyroidism in pregnancy and large compressing goiters should be excluded from the treatment. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4031 INTRA-SELLAR IMPLANTATION OF Y^{90}. COMPARISON OF THE DOSIMETRIC VALUES AND THE CLINICAL RESULTS IN 11 CASES OF CUSHING'S DISEASE. G. Juliani and C. Quaglia (Università, Turin). Minerva Radiol., Fisioterap. Radiobiol., 9: 88-91(1964).

It is possible to establish by calculation the curves of isodoses around cylindrical preparations of ^{90}Y. Knowing approximately (on the basis of autoptic controls) the minimum dose sufficient to produce an acute radionecrosis in the healthy hypophysis it is possible to draw up graphically in the radiological profile of the sella (examined in two projections) the limits within which a definitely destructive dose is absorbed. One has, thus, a direct visualization of the results obtainable with intrasellar implantation of ^{90}Y in relation to the number, site, and charge of the preparations. The method, easy to perform but largely approximative, appears in agreement with the clinical practice: in 11 cases of Cushing's disease a complete agreement between the dosimetric data and the clinical results was found. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4032 RADIATION DIAGNOSIS, RADIATION MEDICAL SCIENCE, AND RADIATION PROTECTION 1962. [PART] IV. F. Ekert (Stahlen- und Physikalisch-Therapeutischen Abteilung im Krankenhaus, Munich). Muench. Med. Wochschr., 105: 1124-31(May 23, 1963). (In German)

Brief reviews are presented of x ray diagnostic techniques, x ray apparatus, appliances, instruments, films, and developers, as well as planning and architecture of radiographic installations, and protection in radiation installations. Techniques for use of contrast media and anesthetics, x-ray diagnosis of internal organs (with the exception of the cerebrum), the skeletal system, including localized diseases, malformations, and variants, and uses of x ray diagnosis during pregnancy and in gynecology are described. Mention is made of diagnosis performed with radioisotopes. For radiotherapy, treatment techniques, apparatus, applicators, and instruments used in the treatment of malignant tumors and their metastases are discussed briefly. Radiotherapy of noncancerous diseases is discussed. Several factors that affect radiation injuries and radiation protection are described. These include radiation injuries, side-effects, radiation sickness, the somatic and genetic hazards of radiation, and radiation protection during x-ray diagnosis and therapy, and during nonmedical use of radioisotopes. 64 references. (BBB)

4033 FAST NEUTRONS FOR RADIATION THERAPY. J. J. Hazel (Royal Victoria Hospital, Montreal). Nucleonics, 22: No. 11, 56-9(Nov. 1964).

The advantages and disadvantages of using fast neutrons for therapy are considered. Neutron absorption, the RBE of fast neutron beams, and the physical and biological problems involved are discussed. (C.E.S.)

4034 THE EFFECT OF INTRA-ARTERIAL HYDROGEN PEROXIDE. R. A. Williams (Middlesex Hospital, London). Proc. Roy. Soc. Med., 57: 638-9(July 1964).

A technique is described that involves perfusing 0.12% hydrogen peroxide (about 250 ml in about 30 min) with radiotherapy given during the last few minutes of the perfusion. Some basic experiments showed that when blood and hydrogen peroxide are mixed there is an increase in oxygenation that is exactly the same as the theoretical calculated increase, which means that all the added oxygen oxygenates hemoglobin. Examination of the mixtures did not show any methemoglobin formation. In terms of milliliter of oxygen per 100 ml of blood this type of perfusion in the external carotid artery produces an increase of 2 ml of oxygen per 100 ml of blood; therefore venous blood would be raised half way to arterial blood. The safety of this technique is discussed and precautions taken to avoid vasospasm are outlined. An experiment in which a rabbit's brain was perfused with hydrogen peroxide showed that this did not result in any damage to the brain. An important question is whether this type of perfusion raises the oxygen tension in the tissues. Methods of measuring oxygen tissue tension are described; a polarized electrode was found to be the only suitable method of measuring tissue oxygen tension and this had been used clinically. One serious contraindication of hydrogen peroxide perfusion is described, i.e., congenital acatalasia. In this rare condition of acatalasia

there is no catalase or peroxidase in the blood. Where there is no catalase in tissues the hydrogen peroxide acts on hemoglobin to make methemoglobin. This deprives the tissues of the oxygenating properties of oxyhemoglobin and necrosis results. If such a patient were perfused with hydrogen peroxide the result would be disastrous biochemically and clinically. However, the very simple routine test of adding hydrogen peroxide to blood would pick out these patients. (BBB)

4035 EXPERIENCES WITH HYDROGEN PEROXIDE PERFUSION IN RADIOTHERAPY FOR CANCER OF THE HEAD AND NECK. R. F. McNab Jones (St. Bartholomew's Hospital, London). Proc. Roy. Soc. Med., 57: 639-41(July 1964).

Experiences are described in the treatment of a small series of patients with advanced cancer in the head and neck by arterial perfusion of hydrogen peroxide combined with external irradiation. The fractionation was over six weeks and the patients were treated three times weekly on a ^{60}Co unit; the total tumor dose was usually about 6000 Rad. The perfusion solution was run in as quickly as the patient could tolerate it, usually taking 20 to 40 min; radiotherapy was given near the end of the perfusion. The growths treated involved the tongue, floor of mouth and mandible, fauces, upper jaw, and the nasal vestibule. Problems involved in catheterization are discussed. Special electrodes were used to measure the PO_2 level in one case of cancer of the tongue, and perfusion with hydrogen peroxide appeared to raise the PO_2 level sixfold. In addition to the difficulties of fixation of the catheter and its maintenance in the correct position for several weeks, there are hazards accompanying the actual perfusion itself. The most serious is a hemiparesis; which is not permanent, recovery beginning about 15 min after onset and being complete in four to six hr. Various explanations are given for the phenomenon. In selecting cases for treatment by this method, advanced growths of the mouth and upper jaw were chosen in which conventional radiotherapy would have been expected to fail. There have been 11 cases in whom the catheterization and perfusion were satisfactory, but generally experience with this method of treatment has been disappointing. It is time-consuming for all concerned, can cause the patient discomfort and even dangerous complications, and the results do not show a dramatic improvement over those obtained by straight radiotherapy. (TCO)

4036 X-RAY GEOMETRY. K. J. Fenz. Radiologe, 2: 407-20(Nov. 1962). (In German)

The optically effective focal point is actually the orthogonal projection of the true focal point in the direction of the central x-ray beam. In dual focus rotating tubes the two foci are adjacent to one another in a radial direction. As a result the optically effective foci lie in the direction of the tube axis, and produce two central beams. The focal midpoint is located to one side of the hood-tube axis. The distance from the axis is significant in transverse emulsion photography. The radiation emerges from the tube focus, but does not obey Lambert's Law. The radiation exit window permits only a fraction of the radiation to be emitted over a fixed solid angle. Each object photographed by x ray can be considered to be made up of a series of superimposed, parallel thin layers. Thus, an x-ray picture can be regarded as a shadow picture that can be made visible by photographic film, light screen, TV screen, etc. The geometric projections are of two general types, orthogonal and diagonal. The ratio of the image size to the actual size of the detail is commonly called the magnification or magnification factor, because it results from geometric magnification. It can be greater or less than 1. Methods are available for representation of thin details. The object thickness often has a significant effect on the sharpness of representation of its edges. An exact size representation of the object can be obtained by orthodiagraphy. There are three groups of factors that can reduce sharpness of x-ray photographs. The first of these results from poor geometry, where the object to be photographed lies outside of the focus. The second is the lack of sharpness that results from movement of the object itself, so that the lack of clarity is "built in." The third set of factors is related to use of poor film or photographic materials. The overall lack of sharpness in x-ray photography varies directly with the lack of sharpness produced by each of these sets of factors. It is not possible to evaluate this arithmetically, because it is a subjective evaluation by the observer. Usually, the total lack of sharpness is minimum if the contribution from the three factors are nearly equally great. These important magnification factors are presented in detail along with many other geometric factors that affect x-ray technique. (BBB)

4037 HIGH-VOLTAGE RADIATION. A. Zuppinger (Universität, Bern). Schweiz. Med. Wochschr., 93: 838-45 (June 15, 1963). (In German)

High-voltage radiation is also known as megavolt or supervoltage radiation. It is an ionizing radiation of electromagnetic or corpuscular type where the quanta energy is at least 600,000 ev. Compared to conventional x radiation it is much more penetrating, and normal tissues are damaged less. It produces much less skin damage because maximum absorption takes place below the skin surface. Tissues, like bone, that contain elements of high atomic numbers are injured less by high-voltage radiation than by conventional radiation. Symptoms of radiation sickness are also less, so that irradiation of tumors of the upper abdomen is more feasible. Use of Ra is one way to administer high voltage radiation. Artificial radioisotopes, such as ^{137}Cs and ^{60}Co, are used for superficial tumors or those at medium depths. Betatron radiation of 20 to 45 Mev is suitable for deep tumors. As a rule of thumb, the depth effect of electrons is $\sim^1/_3$ of the energy in Mev. Clinical experiences with electrons show that they are effective with several tumors that had previously been considered to be radioresistant. These include mixed tumor of the parotid, cylindroma, synovial tumors, chordoma, and chondroma. Tumors in normal tissues that have very high sensitivity to radiation, such as in the genital or inguinal region, can be healed by fast electrons. With conventional radiation this was impossible, or led to such excessive reactions that until now the tumor was usually surgically removed. If this had not been possible, the only recourse left was palliative radiation. Many tumors respond more favorably if they are irradiated preoperatively. The minimal radiation injury and the lower rate of surgical complications observed when high voltage radiation is used preoperatively in place of conventional radiation are definite advantages when for instance, bronchial or gastric carcinomas are treated. (BBB)

4038 CHROMOSOME ANALYSIS AND CLINICAL MEDICINE. W. M. Court Brown (Western General Hospital, Edinburgh). Sci. Basis Med. Ann. Rev., 109-23(1962).

Chromosome studies in malignant disease, particularly leukemia, in which ionizing radiation may be an etiologic agent, are reviewed and some new data presented. Human leukemias have been studied from this viewpoint since the demonstration, largely from the study of the survivors of Hiroshima and Nagasaki, and also of patients treated with x rays for ankylosing spondylitis, that man is susceptible to leukemia induction at least by high doses of radiations. Certain facts are now emerging about the cytogenetics of human leukemias, which may help to throw some light on their etiology. Abnormalities of both the number and morphology of chromosomes have been found in some adults with acute leukemia. Unpublished observations by the author on further patients have shown chromosome abnormalities in nine out of 18 adults with acute leukemia, excluding examples of the acute transformation of chronic myeloid leukemia. Seven of these patients had abnormal numbers of chromosomes in cells cultured from their blood or marrow, and these can be further divided into those with hypodiploid numbers (three cases) and those with hyperdiploid numbers (four cases). The three patients with hypodiploid numbers had in common the fact that they had been exposed to therapeutic doses of ionizing radiations within the decade prior to the clinical development of their leukemia. Patients with such a history of therapeutic exposure within the previous ten years are regarded as hav-

ing a high probability of their disease being radioinduced. However, not all patients with this type of radiation history and developing leukemia show hypodiploid numbers in their leukemic cells. Altogether, seven such patients have been studied, four of which have had hypodiploid numbers. The number of patients involved is small; if, however, the study of more such patients reveals the same trend, the hypodiploid numbers are not found in absence of history of heavy radiation exposure, a real cytogenetic difference may exist between the radioinduced leukemias and those not so induced. It is known from plant and animal studies that ionizing radiations damage chromosomes, and that the damage occurs in two forms. Firstly there is primary or physiological damage from which recovery occurs, and which is essentially a chemical change in the surface coating of the chromosomes rendering them sticky. Secondly, there is secondary damage which is due to actual breaks occurring in the chromosome threads. The relevance of chromosome damage is that it is an important mechanism for the production of the acute effects of irradiation, for example the destructive effects on the hemopoietic system, and an important mechanism whereby tumor cells are destroyed by radiation. It may also be important in the production of such delayed radiation effects as the induction of cancer. It is now possible with the blood culture technique to study the effect of the irradiation of man in vivo. Such studies already show an indication, from the effect of small therapeutic doses of x rays, that chromosome damage is extensive. The damage is revealed by an increase in the number of cells carrying chromosome structural abnormalities of various kinds. Such studies appear to be a more sensitive way of investigating radiation damage in man than any hitherto known. Furthermore, there is the hope that taken in conjunction with epidemiological studies, particularly on leukemia induction, a more realistic estimate may emerge of the potential hazards of exposure to a given dose of ionizing radiation. (BBB)

4039 FUNDAMENTAL ASPECTS OF THE RADIOTHERAPY OF CANCER. H. B. Hewitt (Westminster School of Medicine, London). Sci. Basis Med. Ann. Rev., 305-26(1962).

Various aspects of tumor cell radiosensitivity are discussed, with particular reference to the author's recent studies. One such experiment concerned the relation between the dose of radiation delivered to a tumor cell population in vivo and the proportion of cells which retain their reproductive integrity. Unanesthetized mice bearing a malignant condition (either leukemia or a solid tumor) were exposed to whole-body ^{60}Co γ radiation delivered at an ordinary clinical dose rate of 70 to 80 R/min. Very soon after irradiation a single-cell suspension of the malignant cells was prepared from the irradiated mouse and a transplantation bio-assay method used to determine the proportion of malignant cells which had lost their cell survival rates at dose levels between 600 R and 2000 R were determined as well as a curve showing the relation between the dose of radiation and the logarithm of the survival rate. The straight line defining the relation does not extrapolate back to 0 log (100% survival) at zero dose, but to 0.3 log. It was not possible to determine the upper part of the curve in detail, but it can be assumed that this in vivo curve has the same character as radiation survival curves for tissue cells irradiated in vitro, in which case the upper part of the curve would be a curved line starting at 0 log (100% survival) and gradually increasing its slope until the linear part is attained. This apparently insignificant part of the curve is of great importance in relation to dose fractionation. The survival-rate experiments were repeated on the leukemia strain with one alteration of the conditions: instead of irradiating the cells in living leukemic mice, they were killed by neck fracture a few minutes before exposure. Under these conditions it can be inferred that the rapidly metabolizing leukemia cells would be under anoxic conditions at the time of irradiation. It was possible again to demonstrate an exponential relation between the dose of radiation and the survival rate, but the reproductively intact cells fall off very much more slowly, as the dose of radiation is increased, than do the cells irradiated in living mice. For any given survival rate, the dose required for anoxic cells is greater than that for well-oxygenated cells by a factor 2.3. This figure is a typical representation of the oxygen effect as demonstrated by others using quite different measures of radiosensitivity. The character of these curves is of considerable importance in relation to the radiotherapy of tumors, because it is probable that many tumors are a mixture of anoxic and well-oxygenated cells. A feature of these survival curves for the leukemia and the sarcoma is their similarity. Incomplete data for two other leukemias, of different growth rates and cell sizes, suggest that these also will give curves of much the same slope. (BBB)

4040 INVESTIGATION OF THE CONTRIBUTION OF RADIOEMANOTHERAPY IN THE RESULTS OF COMBINED SPA AND CLIMATIC TREATMENT AT SOKOBANJA. M. Radić, V. Godić, L. Radovanović, and M. Bojanić (Balneo-Klimatol. Inst., Belgrade). Srpski Arkiv Celokupno Lekar., 91: 1033-40(1963).

The influence of radon inhalation on the number of eosinophils in the peripheral blood of 20 adults suffering from allergic bronchial asthma was investigated in the emanatory of the Spa Sokobanja. On the first day the spontaneous variation of the number of eosinophils in the time interval 7 to 11 hrs was determined. On the next day the determination was repeated after the patient had inhaled radon for 30 min. Statistical evaluation shows that the inhalation had a definite eosinopenic effect. Although the mechanism of radioemanotherapy in the natural climatic resorts is not yet clarified the authors believe that the effect is linked to the absorption of radon in the nervous and endocrine systems. The favorable clinical results of combined Spa and climatic treatment of allergic bronchial asthma would therefore be attributable not only to the climatic influence but also to the radioemanotherapy. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4041 ON DISORDERS WHICH ARE ACCOMPANIED BY INCREASED I-131 UPTAKE AND STORAGE BY THE THYROID. M. Policzer, E. Bazso, and M. Marton. Z. Aerztl. Fortbild., 56: 820-3(1962). (In German)

In the course of the analysis of 119 cases with increased ^{131}I uptake and/or ^{131}I storage, it was established that these functional tests of the thyroid can show increased values in both hyperthyrotoxicosis and in diseases other than thyroid disorders. This means that the results of a thyroid function test alone can give no reliable diagnostic data. The modification of a partial function of the thyroid frequently originates from various causes, following different mechanisms. In addition to earlier diagnosis of hyperthyrotoxicosis, the increase of thyroid avidity, as storage, can be evaluated. In various internal illnesses, the iodine storage is usually high and the avidity is, in general, normal. Enlargment of the thyroid occurs in hyperthyrotoxicosis and vegetative dystonia, but very seldom in internal illnesses. (tr-auth)

4042 RADIATION PROTECTION OF PATIENTS DURING X-RAY DIAGNOSIS OF THE HIP JOINT. K. Brezina (Zentral-Roentgeninstitut des Kaiser-Franz-Josef-Spitals, Vienna). Z. Orthopaed. Ihre Grenzgebiete, 95: 449-55(Apr. 1962). (In German)

Radiation protection of the pelvic organs and the adjoining skeletal areas during x ray diagnosis has recently received much attention. This is not so much because of the possibility of direct injury of the tissues irradiated, but more because of the special protection that the gonadal organs should have to prevent genetic radiation injuries. This damage does not affect the persons irradiated directly as much as it does their progeny. In order to protect the gonads of infants and children subjected to x ray diagnosis, Pb plates of 1 mm thickness have been developed. For females the plate is approximately triangular in shape and is lengthened somewhat in the cranial direction. For protection of the testis the shield is constructed in an almost oval shape. Naturally, the effective radiation exposure that a patient receives during x ray studies of the hip joint depends on the size of the patient, and the contrast required. In infants when these shields are used the surface dose is ~40 mR, and in older children it is ~500 mR. In fat pa-

tients it is slightly more than this. The dose at the under surface of the shields is never more than 5% of the dose at their exposed surfaces. On this basis, 20 times as many photographs could be taken, using these Pb shields, before the radiation exposure would amount to as much as if the shields were not used. Although this exposure is not absolutely noninjurious in a genetic sense, it is surely not excessive in a medical sense. However, these considerations do have significance for children, because their entire reproductive life lies before them, and there may be many repetitions of x-ray studies during the years that lie ahead of them. (BBB)

4043 RADIATION DATA FOR MEDICAL USE. Catalogue of Data Sheets Obtainable from the International Atomic Energy Agency. MDS/CAT/1/1964. (International Atomic Energy Agency, Vienna). 74p. (IAEA).

A catalog of radiation data sheets of interest in radiotherapy is presented. Physical data used in clinical dosimetry, data on radium surface and implant doses, and isodose charts for medium energy x radiation, high-energy x radiation, ^{137}Cs γ sources, ^{60}Co γ sources, electron beams, and moving beam dose distributions are included. A list is appended of manufacturers of high-energy radiotherapy equipment. 30 references. (C.H.)

CHEMISTRY

General

Refer also to abstract 4349.

4044 (ORINS-47) BLUEPRINTS OF AN AUTOMATIC ZONAL SCRAPER AND SAMPLE COLLECTOR FOR RADIOASSAY OF THIN-LAYER CHROMATOGRAMS. Fred Snyder and Harry Kimble (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). Contract AT-40-1-GEN-33. 27p. Dep.; $2.00(cy), 1(mn) OTS.

Blueprint drawings are given for a completely automati zone scraper and sample collector for thin-layer chromatoplates. The scraper cuts the plate in increments of 1, 2, or 5 mm each which then fall into vials on an automated tray. The 24 vials on the tray can be filled with scrapings in one minute and then prepared for liquid scintillation counting. A zonal scan of an impure tripalmitin-^{14}COOH is included which shows the resolution obtainable using automatic recording of the counting rate per vial. (D.L.C.)

4045 (ORNL-3627) CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1964. (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 319p. Dep.; $7.00 (cy), 5(mn) OTS.

Progress in chemical technology research is reported in 19 topical sections. Separate abstracts were prepared for 17 of the sections. The two sections for which no abstracts were prepared were concerned with radiation damage to ion exchange resins and chemical assistance programs. (J.R.D.)

For abstracts of individual sections see: 4046, 4047, 4105, 4196, 4246, 4247, 4248, 4249, 4250, 4251, 4252, 4253, 4254, 4255, 5450, 5451, and 5558.

4046 (ORNL-3627(p.247-8)) DECONTAMINATION OF EQUIPMENT. (Oak Ridge National Lab., Tenn.).

A program for development of improved methods for the removal of fission products and U compounds from contaminated metal surfaces in nuclear reactors is described. Equipment that can be adequately decontaminated without significant corrosion damage may be maintained directly instead of remotely; it also can be restored to service without extensive and costly replacement of corroded parts. The program has been concerned chiefly with continuing the development and testing of decontamination reagents for gas-cooled reactors. A new room-temperature decontamination method was developed for carbon steel. The method is based on a 5-min dip in 0.02 M oxalic acid followed by a 5-min dip in the same solution containing 0.05 M H_2O_2. Carrier-free ^{131}I and ^{137}Cs were volatilized, deposited on metals at various temperatures, and then decontaminated from metal surfaces. Stainless steel from an in-pile He loop was also decontaminated using this method. In several tests of the deposition of fission products, conducted in the Oak Ridge Research Reactor, the level of the activity deposited from graphite-clad fuel balls was too low to permit meaningful measurements. Noncorrosive fluoride-containing reagents were further developed for decontaminating stainless steel exposed to contaminated He at about 1200°F. Other contributions to decontamination research include a fluoride-containing reagent developed for the simultaneous decontamination of Zircaloy-2, carbon steel, and stainless steel and oxalate-peroxide reagents formulated for the decontamination of Ni vessels in the Fluoride Volatility Pilot Plant. (auth)

4047 (ORNL-3627(p.256-8)) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS. (Oak Ridge National Lab., Tenn.).

The major effort this year was devoted to the development of a chemical flowsheet for the recovery of transplutonium elements from salt debris produced in Project Coach, a planned underground nuclear explosion. Smaller efforts were devoted to studies on the production and recovery of radioisotopes by jet sampling and on the feasibility of a bubble-tapping line to obtain samples from the blast zone immediately after the explosion. (auth)

4048 (ORNL-3733) THE PREPARATION OF PURE BERYLLIUM OXIDE BY SOLVENT EXTRACTION WITH ACETYLACETONE IN THE PRESENCE OF ETHYLENEDIAMINE TETRAACETIC ACID: PROCEDURE AND CHEMISTRY. C. E. L. Bamberger, H. F. McDuffie, and C. F. Baes, Jr. (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 51p. Dep.; $3.00(cy), 1(mn) OTS.

A procedure for the preparation of high purity beryllium hydroxide has been demonstrated on a kilogram scale and systemmatic study of its chemistry has been completed. The starting material, $Be(OH)_2$, is dissolved in a CCl_4 solution of acetylacetone, HX, to form the chelate BeX_2. Metallic impurities are removed by extraction with aqueous EDTA, the beryllium is back extracted with aqueous HNO_3, and beryllium hydroxide is precipitated with ammonia. The original procedure was modified to include removal of HX from the HNO_3–$Be(NO_3)_2$ strip solution by chloroform scrubbing and precipitation of beryllium, in the presence of EDTA with gaseous ammonia at 75°C. The product was a granular, easily dried, free flowing powder having approximately the composition $Be(OH)_2 \cdot 0.3H_2O$. Ignition of the product, 4 kg of which was prepared in 85% yield in one-kilogram batches in all-plastic bench-scale equipment, gave BeO in which the total of measureable metallic impurities was <5 ppm. The variation of the following equilibrium parameters with aqueous ionic strength and/or organic phase composition is summarized and discussed: the formation quotients of BeX^+ and BeX_2, the distribution coefficients of BeX_2 and HX; and the aqueous solubility of BeX_2. The distribution behavior of some 15 cations was, in some cases, determined and, in most cases, estimated from known equilibrium quotients. Al^{3+} and Cr^{3+} were the only cations of those considered which were not satisfactorily removed by the solvent extraction steps; however, Al^{3+} is retained in solution by EDTA during the precipitation step, and Cr^{3+} reacts so slowly with HX that it was not found to be a problem. The rates of beryllium extraction and back extraction are limited by the efficiency with which the two liquid phases are contacted. The rate of formation or hydrolysis of aqueous BeX_2, in which equilibrium was usually reached in a few minutes, was evidently determined by the rate of formation of hydrolysis of BeX^+, permitting estimates of the effect of pH and HX concentration on the rate. The rate of Fe^{3+} removal from the organic phase by EDTA was relatively slow, requiring about 3 hrs for each scrub step. (auth)

4049 (ORO-625(p.93-102)) FISSION PRODUCT CHEMISTRY OF SOILS. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Progress is reported in studies on the interrelations of fission product elements and the mineral clay fractions of soils. Emphasis was placed on the mechanism controlling the transfer of a cation from the soil particle to the root surface and studies of soil properties that effect the availability of fission product elements to plant roots and factors that can quantitatively alter the availability. Data are presented from studies of the rate processes involved in cation movement in clay-water systems with increasing levels of free electrolyte; counter diffusion measurements in bentonite; the development of new techniques for ionic self-diffusion measurements in clay; the fixation of cations by clays; and the effect of freeze-drying and rehydration on the surface behavior of bentonite. (C.H.)

4050 (UCRL-11612) NUMERICAL EVALUATION OF CURRENT DISTRIBUTION IN ELECTRICAL SYSTEMS.

R. N. Fleck, D. N. Hanson, and C. W. Tobias (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Dept. of Chemistry). Sept. 1964. Contract W-7405-eng-48. 114p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Thesis submitted by R. N. Fleck.

A computer program has been written in FORTRAN language for the numerical solution of the Laplace equation with non-linear boundary conditions. The specific application is for the solution of the current flows and potential fields in a well-stirred electrochemical cell with or without polarization. Arbitrary geometries are handled. The program employs both doubling and overrelaxation to accelerate the convergence. A listing of the program is included. A new empirical method has been developed to determine the optimum overrelaxation factor and it appears to have specific applications for non-rectangular geometries and/or non-linear boundary conditions. A catalogue of analytical solutions for the Laplace equation has been prepared from information in the literature. (auth)

4051 DECONTAMINATION OF RADIOACTIVE CONTAMINATION BY VARIOUS SURFACE ACTIVE REAGENTS. Kazuo Takada (Mitsuwa Soap Co., Ltd., Japan), Yoshiki Wadachi, and Yoshito Yamaoka. Nippon Genshiryoku Gakkaishi, 6: 575-9(Oct. 1964). (In Japanese)

The decontamination abilities of various surface-active reagents were tested with cotton, at different concentrations and pH values, to determine their effectiveness in decontaminating extremely small amounts of radioisotopes. Co^{2+} (labeled with ^{60}Co) and PO_4^{3-} (labeled with ^{32}P) were chosen for cationic and anionic contaminants, respectively. In almost all cases, the decontamination of carrier-free isotopes is more difficult than that of isotopes with carriers. For cationic contamination, the decontamination ability of anionic surface-active reagents increased markedly beyond their critical micelle concentration. On the other hand, very good decontamination ability was recognized for cationic surface-active reagents in a wide range of concentration. On the other hand, nonionic surface-active reagents had no decontaminating effect in the whole concentration range studied. Amphoteric surface-active reagents exhibited a fairly large decontaminating power, which was sensitively affected by pH. All of the surface-active reagents used showed no decontamination ability for anionic contamination. (auth)

4052 CHEMICAL REACTIONS INVOLVING MUONIUM. A METHOD FOR DETERMINING THE RATE CONSTANTS AND OTHER REACTION PARAMETERS. V. G. Firsov and V. M. Byakov (Inst. of Theoretical and Experimental Physics, Erevan). Zh. Eksperim. i Teor. Fiz., 47: 1074-83(Sept. 1964). (In Russian)

It is shown that depolarization of μ^+ mesons in matter can be explained by assuming that the muonium hydrogen-like atom is capable of reacting chemically just as atomic hydrogen does. A number of phenomena which should appear in this case are considered. It is shown that the absolute rate constants for hydrogen reacting with various acceptors can be determined by measuring the μ^+ meson decay asymmetry coefficient. (auth)

4053 STABILIZATION OF ORGANIC FLUIDS AGAINST RADIATION DECOMPOSITION. Mark Elias Gutzke and William Harry Yanko (to Monsanto Co.). British Patent 969,275. Sept. 9, 1964. Filed May 7, 1962.

A polyphenylic fluid is described which has increased stability against radiation and therefore is useful as a reactor moderator/coolant. The fluid comprises a mixture of a polyphenyl and a hydrogenated polyphenyl, the amount of hydrogenation being 5 to 25% of that required for complete saturation of the mixture. The polyphenyl may be biphenyl, terphenyls, quaterphenyls, or alkyl derivatives thereof, and the mixture may be formed either by mixing or by partial hydrogenation of the polyphenyl. Several examples of the preparation and properties of such mixtures are given. The use of partially hydrogenated Santowax R in a power reactor is discussed. (D.L.C.)

Analytical Procedures

Refer also to abstracts 4504, 4526, and 4842.

4054 (AE-159) A SIMPLE APPARATUS FOR FAST ION EXCHANGE SEPARATIONS. K. Samsahl (Aktiebolaget Atomenergi, Stockholm). 1964. 15p. Dep.(mn).

An apparatus suitable for very fast ion exchange group separations in radiochemistry has been elaborated. The apparatus which consists of a system of glass tubes with pistons driven by the same force, allows the exact adjustment of influent solutions to a long series of ion-exchange columns. The practical application of the apparatus to the simultaneous separation of six groups of trace elements in the neutron activation analysis of biological material is described. (auth)

4055 (BNL-8034) NUCLEAR ACTIVATION AUTORADIOGRAPHY OF OIL PAINTS. A PRELIMINARY STUDY. Heather N. Lechtman and Edward V. Sayre (Brookhaven National Lab., Upton, N. Y. and New York Univ., New York. Inst. of Fine Arts). [nd]. Contract AT-30-2-GEN-16. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Neutron activation autoradiography of an oil painting frequently gives considerable information in addition to that obtainable by x radiography. The technique involves thermal neutron activation of the painting followed by contact of the irradiated painting with a photographic film. The effectiveness of the technique is due to the fact that colored pigments are activated strongly while white pigments and support materials are not. Various modifications of the technique and examples of the results obtained are discussed. Possible radiation damage of the paintings is discussed. (D.L.C.)

4056 (CONF-715-2) THE DETERMINATION OF CALCIUM IN URANIUM ORE CONCENTRATES BY X-RAY FLUORESCENCE. D. R. Knoke and H. F. Waldron (Mallinckrodt Chemical Works. Uranium Div., St. Charles, Mo.). July 9, 1964. Contract W-14-108-eng-8. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From 13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 1964.

A description is given of the successful application of the vacuum path x-ray spectrometer for the determination of calcium in the range of 0.03 to 1.75% (on a U_3O_8 basis) in uranium ore concentrates. The procedure provides a 50% savings in analyst time, with no sacrifice of accuracy or precision, compared to the chemical method previously used. With a chromium target tube, the intensity of the calcium radiation is quite sufficient for accurate analyses even though the samples contain approximately 80% uranium. The heavy uranium matrix actually serves to minimize any absorption or enhancement effects that would normally be expected from the large number of impurities that are present in widely varied concentrations. Samples are prepared by dissolving 1.8 g of concentrate in 10.0 g of $Na_2B_4O_7$ at 1050°C and casting into a disc on a polished aluminum plate. The advantages of this preparation compared to the use of pelletized powders are discussed. The CaKα-to-UMγ ratio is used to minimize the effect of instrumental and sample variations and to provide a linear relation with respect to the calcium concentration on a U_3O_8 basis. Calibration standards are prepared by the addition of $CaHPO_4$ to either pure U_3O_8 or a uranium ore concentrate of low residual calcium. Data obtained during routine application of this procedure are presented. (auth)

4057 (EURAEC-1159) PLUTONIUM RECYCLING—PLUTONIUM ASSAY BY ISOTOPIC DILUTION. J. Chenouard and M. Lucas (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). June 16, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 037-13-12 RDF. 41p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The uranium/plutonium ratio in a fuel after irradiation can be determined by isotopic dilution using a solution containing uranium-233 and plutonium rich in isotope 240

or 242. The measurement method, its calibration, the techniques of preparing the solutions and mass spectrometry analysis are described. Carrying this program into effect necessitates the assurance that, after mixing, the isotopes will be distributed in the same manner throughout the system for atoms originating from the sample or from the tracer. This condition leads to difficulties which are revealed particularly during calibration. The use of an electronic computer enabled the analysis time to be cut down and the verification of the results to be simplified. The U/Pu ratio can be determined to within 3 to 4% if a tracer rich in ^{240}Pu is used; to better than 2% using ^{242}Pu. The ^{235}U consumption is measured using a special technique involving analysis of uranium hexafluoride. Impoverishment is determined to approximately 5×10^{-4}. (auth)

4058 (LA-DC-6722) COMPARISON OF FOUR TITRIMETRIC METHODS FOR ASSAYING PLUTONIUM. Glenn R. Waterbury and C. F. Metz (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 15p. (CONF-805-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

For presentation at European-American Nuclear Data Committee Meeting, Brussels, Jan. 1965.

Four of the existing plutonium assay methods were evaluated by comparing results obtained for the assay of high-purity plutonium metal. The methods included in this evaluation were redox titrations in which the endpoint was detected amperometrically, photometrically, or potentiometrically. Each method was found to be satisfactory in this application. High americium concentrations caused a slight effect on the amperometric titration, but this effect was not significant for lower americium concentrations of 200 to 300 ppm. For high-purity plutonium the results obtained by the four methods were essentially equal. (auth)

4059 (LA-DC-6723) STATUS OF THE U. S. PROGRAM TO ESTABLISH A PRIMARY STANDARD FOR PLUTONIUM. Glenn R. Waterbury and Charles F. Metz (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 21p. (CONF-805-1). Dep.(mn); $1.00 (cy), 1(mn) OTS.

For presentation at European-American Nuclear Data Committee Meeting, Brussels, Jan. 1965.

The present status of the U. S. program to establish a primary standard for plutonium is reviewed. Of the many plutonium-containing materials considered, three salts are undergoing testing. These salts are anhydrous plutonium sulfate, plutonium sulfate tetrahydrate, and dicesium plutonium hexachloride. Preliminary results indicate that these materials may not prove to be entirely satisfactory as plutonium standards. Plutonium metal packaged in an inert atmosphere is serving satisfactorily as the plutonium primary standard at this time. (auth)

4060 (NP-14469) GAMMA-RAY SPECTRA OF NEUTRON ACTIVATED ELEMENTS. Oswald U. Anders (Dow Chemical Co., Midland, Mich.). Apr. 1964. 70p.

Gamma spectra are presented for elements of atomic number ranging from 4 to 92. The spectra can be used to identify the components in activated gamma spectra of analytical samples and to estimate the sensitivity of the method for specific elements. (D.L.C.)

4061 (PG-Report-516) ANALYTICAL METHODS FOR THE ANALYSIS OF URANIUM MONO- AND DiCARBIDES (THE DETERMINATION OF IRON, NICKEL AND MOLYBDENUM). (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 28p. Dep.(mn); $1.00(BIS); 5s.(HMSO).

Two methods are given for the absorptiometric determination of iron, the first using 1,10-phenanthroline for iron contents below 50 ppm and the second using thioglycollate for higher ranges of iron contents. Nickel is determined absorptiometrically with dimethylglyoxime, the complex being first isolated by chloroform extraction and then re-extracted into an acidic aqueous phase. Toluene-3,4 dithiol is used as the reagent for the absorptiometric determination of molybdenum, the complex being extracted into carbon tetrachloride from an aqueous solution whose acidity is controlled for optimum complex formation. These methods have been applied to the carbides when the concentrations of the impurity elements have come within the following ranges: iron, 0 to 1500 ppm; nickel, 5 to 70 ppm; and molybdenum, 0 to 40 ppm. (auth)

4062 (PG-Report-586) ANALYTICAL METHOD FOR THE POLAROGRAPHIC DETERMINATION OF HEXAVALENT URANIUM IN URANIUM DIOXIDE. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 13p. Dep.(mn); $0.70(BIS); 3s.6d.(HMSO).

The sample is dissolved in phosphoric acid and, after dilution with sulfuric acid, hexavalent uranium is determined polarographically. The method is applicable to the determination of hexavalent uranium in sintered uranium dioxide fuels and stabilized uranium dioxide powder. It does not apply in the presence of organic binding agents. The precision is ±0.03% w/w U^{VI} (1 × sigma) in the range 0.05 – 1.0% w/w U^{VI}, and ±4% relative (1 × sigma) in the range 1 – 10% U^{VI}. (auth)

4063 (PG-Report-623) ANALYTICAL METHOD FOR THE DETERMINATION OF SULPHUR IN CARBON DIOXIDE. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1964. 6p. Dep.(mn); $0.20(BIS); 1s.2d.(HMSO).

The sample is mixed with oxygen and heated to 1200°C where sulfur compounds are oxidized and sulfur dioxide is formed. This is absorbed in sodium tetrachloromercurate solution and the sulfur determined absorptiometrically as the sulfonic acid derivative of fuchsin. The method is mainly intended for the determination of the total sulfur in the carbon dioxide feed gas or circuit gas of gas-cooled reactors of the Calder Hall or A.G.R. type. The concentration range is 0.1 to 5 ppm w/w of sulfur in carbon dioxide. The only known interference is from nitrogen dioxide. (auth)

4064 (RTD-TDR-63-4082) THE DETERMINATION OF TRACE AMOUNTS OF BORON IN MOLYBDENUM. K. F. Sugawara (Wright Air Development Center. Materials Lab., Wright-Patterson AFB, Ohio). Nov. 1963. 17p. (AD-425811). OTS.

The mechanical properties of molybdenum are appreciably affected by the addition of small amounts of boron to the metal during the arc melting process. Thus, a need exists for the rapid and accurate determination of boron in these molybdenum samples. A reliable method has been established for the determination of 1 to 25 micrograms of boron in molybdenum. Dissolution of the metal is effected with a fusion mixture of sodium carbonate and sodium nitrate. The boron is selectively separated by distillation and then determined spectrophotometrically, using carminic acid reagent. In addition, a study was completed to determine the most efficient manner in which the distillation can be accomplished. The sensitivity is approximately 20 parts per million boron in molybdenum, but the sensitivity can be extended by using larger samples. (auth)

4065 (SGAE-CH-8/1964) DESTRUCTIVE ANALYSIS OF UNIRRADIATED AND IRRADIATED FUELS. Final Report. (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Vienna). July 1964. Contract 121/R-1/RB. 28p. Dep.

U was determined in standard solutions, unirradiated U oxides, and alloyed fuel plates by ceric sulfate titration. In the 15-to-30-mg range the accuracy was 0.22 to 0.27% and in the 100-to-200-mg range, 0.12%. Using chromous chloride for the U reduction and a recording potentiograph, U could be determined at the 30-mg level even in the presence of large amounts of Al with ±1% precision. By the same method U could be assayed quantitatively directly in the solution of an irradiated fuel element as well as after separation by ion exchange and solvent extraction. Pu was isolated from this solution by solvent extraction and determined by α counting combined with α spectroscopy and mass spectrometry. A spectrophotometric determination using thoron and paper chromatographic separation of U and Pu, was also investigated. (auth)

4066 GAS CHROMATOGRAPHIC AND ISOTOPE DILUTION ANALYSIS OF ISOMERS FORMED ON MONONITRATION OF BENZOIC ACID. Bianca Aliprandi, Fulvio Cacace, and Giovanna Ciranni (CNR, Rome and Università, Rome). Anal. Chem., 36: 2445-7(Dec. 1964).

A technique involving combination of the isotope dilution method with preparative-scale gas chromatography for analysis of complex reaction mixtures is described. An example of application to the analysis of the isomers formed on mononitration of benzoic acid is given. The results are compared with those from a conventional gas chromatographic analysis. (auth)

4067 CORRECTION OF QUENCHING IN LIQUID SCINTILLATION COUNTING OF HOMOGENEOUS SAMPLES CONTAINING BOTH CARBON-14 AND TRITIUM BY EXTRAPOLATION METHOD. C. T. Peng (Univ. of California, San Francisco). Anal. Chem., 36: 2456-61(Dec. 1964).

An extrapolation method for quenching correction in doubly labeled samples is described. The samples are integral-counted at different concentrations in a two-channel liquid scintillation spectrometer, which is adjusted to afford the counts of ^{14}C in the first channel and ^{14}C and ^{3}H in the second channel. Degrees of quenching in these two channels are shown to be a simple and a composite exponential function of the sample concentration, respectively. In addition, attenuation of background counts by quenching in each sample can be estimated from a correlation curve. Merits of integral vs differential counting of doubly labeled samples are also discussed. (auth)

4068 ION EXCHANGE DETERMINATION OF URANIUM IN FERROUS ALLOYS. Johann Korkisch and Isidor Hazan (Universität, Vienna). Anal. Chem., 36: 2464-6 (Dec. 1964).

A medium consisting of 90% methyl glycol–10% 6N hydrochloric acid was employed for the quantitative separation of microgram and milligram amounts of uranium from large quantities of iron, aluminum, alkaline earth metals, lanthanides, and many other elements by means of ion exchange using the strongly basic anion exchanger Dowex 1, X8. From this hydrochloric acid–organic solvent mixture, uranium is strongly adsorbed on the resin, whereas practically all other metal ions except copper, zinc, cadmium, lead, bismuth, cobalt, tin, and manganese are not retained, so that a quantitative removal of these elements from uranium can easily be effected. Subsequent washing with 80% methyl glycol–20% 3N hydrochloric acid also removes copper, cobalt, and manganese. Elution of uranium is effected with 1N hydrochloric acid and only lead accompanies the uranium into the eluate. A feature of this method is the fact that tervalent iron, even if present in huge amounts, can easily be separated from uranium, thus making possible the determination of the latter element in samples such as ferrous alloys. The results of the analysis of several steel samples showed that this method can be employed successfully for this purpose. (auth)

4069 RADIO RELEASE DETERMINATION OF VANADIUM IN WATER. Arthur S. Gillespie, Jr. and Harold G. Richter (Research Triangle Inst., Durham, N. C.). Anal. Chem., 36: 2473-4(Dec. 1964).

Vanadium in aqueous solution can be determined quantitatively by the radio release method. The vanadate ion is assayed by acidifying the sample (pH <3) and pouring it through a column containing radioactive metallic ^{110}Ag. The reaction can be written as: $V(OH)_4^+ + 2H^+ + Ag \rightarrow VO^{2+} + Ag^+ + 3H_2O$. The silver ions are released into the solution where their concentration may be measured by Geiger or scintillation counting. Sensitivity attained was 0.1 ppm of vanadium. Reproducibility at the 1-ppm level was ±2%. Ferric and chloride ion interferences were studied and could be suppressed or eliminated by addition of appropriate complexing agents. Vanadium ions with valences less than +5 could be assayed by oxidizing to $V(OH)_4^+$ with Cl_2. (auth)

4070 AMINE EXTRACTION—SPECTROGRAPHIC DETERMINATION OF TANTALUM, TITANIUM, TUNGSTEN, AND ZIRCONIUM IN PLUTONIUM. Roy Ko (General Electric Co., Richland, Wash.). Anal. Chem., 36: 2513-14 (Dec. 1964).

Amine extraction and spectrographic analysis were used for determination of Ta, Ti, W, and Zr in plutonium. Plutonium is dissolved in HCl and extracted into 20% tri-n-octylamine. Effects of fluoride on the extraction were studied. The method was tested by spiking plutonium solutions and 88 to 100% spike recoveries were obtained. (M.C.G.)

4071 NONDESTRUCTIVE NEUTRON-ACTIVATION ANALYSIS OF SMALL PARTICLES. William A. Cassidy (Columbia Univ., Palisades, N. Y.). Ann. N. Y. Acad. Sci., 119: 318-38(Nov. 11, 1964).

Welding beads, spherules from smoke and soot, spherules collected in plankton nets, spherules from the ocean floor, and known natural spherules were subjected to neutron activation analysis in order to determine if this technique could be used to establish the composition of natural spherules and to determine whether spherules are natural or artificial. (D.C.W.)

4072 A METHOD FOR GAS CHROMATOGRAPHIC ANALYSIS OF LABELED SUBSTANCES. H. W. Schulze and H.-K. Bothe (Institut für Angewandte Radioaktivität, Leipzig). Atomkernenergie, 9: 363-9(Sept.-Oct. 1964). (In German)

A flow G-M counter for gas chromatography, operating in a range of temperatures from 30 to 180°C, is described. It enables analysis of tritium- and ^{14}C-labeled organic compound. A tenfold amount of an argon/isobutanol mixture is added to hydrogen carrier gas, containing the previously separated radioactive components. A formula is given for calculating the specific activity of the components. Moreover, a method is described, which permits taking down, simultaneously with one recorder, the chromatogram of the thermal-conductivity cell and the radioactivity of the components. (auth)

4073 DETERMINATION AND SEPARATION OF PROTACTINIUM OF MASS 231 FROM SILICEOUS RESIDUES OF JOACHIMSTHAL PITCHBLENDE. Pierre Conte, Jacques Vernois, Daniel Robertson, and Roland Muxart (Université de Paris, Arcueil, France). Bull. Soc. Chim. France, No. 9, 2115-16(Sept. 1964). (In French)

Methods for the determination of protactinium in the siliceous residues of Joachimsthal pitchblende and its extraction from these residues are described. The results obtained show that chlorination by dry methods followed by fractional sublimation of the chlorides formed make possible a rapid determination with a precision of the order of 15%. The utilization of ammonium acid fluoride permits an efficient, rapid, and relatively easy attack. (tr-auth)

4074 ION EXCHANGE SEPARATION OF RUBIDIUM AND CESIUM. Yoshiaki Maruyama (Musashi Inst. of Tech., Kawasaki, Japan). Bunseki Kagaku, 13: 956-60(Oct. 1964). (In Japanese)

Ion exchange separation of Rb and Cs was studied by the batch and the column methods using ^{86}Rb and ^{137}Cs as radioactive tracers. The cation exchanger Diaion SK #1 was chosen, and 0.5N and 0.75N HCl were used for the eluant. The distribution coefficients K_d were determined by the batch method. The apparent K_d were invariable when Rb or Cs carrier increased from trace quantities to about 5 mg, and decreased thereafter. The separation factors α also were determined by the batch method. Their values of K_{dRb}, K_{dCs}, and α were 43.0, 56.6, and 1.32 in the 0.5N HCl, and were 25.9, 33.5, and 1.29 in the 0.75N HCl respectively. The elution curves were taken for Rb and Cs by the column method. The distribution coefficients K_d and separation factors α calculated from the column experiments coincided with those by the batch method. Also 0.15N NH_4 acetate solution was used to elute Rb and Cs, but the separation was less effective than the elution by HCl. At last 0.1N $Ba(OH)_2$ solution was used for the treatment of a large amount of material, and about 300 mg crude Rb (containing Cs) was purified experimentally. (auth)

4075 DETERMINATION OF LEAD-210 BY DITHIZONE EXTRACTION OF BISMUTH. Takashi Ashizawa, Kikuo Nagasawa, and Kanji Haruyama (Atomic Fuel Corp., Ibaraki, Japan). Bunseki Kagaku, 13: 1011-16(Oct. 1964). (In Japanese)

The cause of abnormality in the dithizone extraction of trace of bismuth from an acidic solution was clarified. A minimum extractability appeared at pH 4 in the presence of citric acid and at pH 6 in the presence of halogen ions. The tendency was increased in the chloroform solution more so than in the carbontetrachloride solution. Although the pH 2.5 ~ 3.5 had been hitherto considered as the optimum condition for the extraction of bismuth, it is recommended that the extraction from the solution be adjusted to pH 1.5 by nitric acid and ammonia in the presence of acetate ion, whereby trace bismuth could be separated completely even from 1 g of lead. Phosphate and sulfate also disturbed the extraction. An optimum condition was determined for the extraction with 10 ml of dithizone (1×10^{-3}M)-carbontetrachloride from 50 ml of aqueous solution of pH 1.5. ^{210}Pb in a uranium ore from Ningyo-Toge mine was preliminarily separated by the precipitation as lead sulfate using a large amount of lead carrier, the daughter ^{210}Bi was extracted by the proposed method, and the β-activity was measured for the determination of ^{210}Pb. The amount of ^{210}Pb was only 75% of that expected from the radiation equilibrium. (auth)

4076 DETECTION OF RADIOACTIVITY IN CONTAMINATED SEAWATER; METHODS DEVELOPED IN JAPAN. Comit. Nazl. Energia Nucl., Notiziario, 10: No. 2, 60-2(1964).

An analytical method to detect isotopes in very low concentrations in seawater was developed in anticipation of the continuing increase of radioactive waste unloaded in the sea. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4077 NON-DESTRUCTIVE DETERMINATION OF THE INORGANIC COMPOSITION OF BONE TISSUE BY RADIOGRAPHIC DENSITOMETRY. Willy Mouvet (Université, Brussels). Compt. Rend., 259: 2309-11(Oct. 5, 1964). (In French)

A method for the nondestructive determination of the mineral components of bone tissue, applicable in radiodiagnosis, is proposed. A means of setting up, by densitometry, the absorption curve in a reference material (aluminum) of the x-ray beam used is suggested. The problems posed by the polychromatism of the radiation and by the diffusion of the irradiated material can be resolved with this curve. (tr-auth)

4078 ACTIVATION ANALYSIS DETERMINATION OF THE Zr–Hf RATIOS IN STONE METEORITES AND MINERALS. Von E. Merz and E. Schrage (Kernforschungsanlage, Julich, Ger.). Geochim. Cosmochim. Acta, 28: 1873-7(Nov. 1964). (In German)

Methods for determination of Zr–Hf ratio in stone meteorites and minerals by activation analysis are described. Gamma spectra are shown and compared for pure zirconium and hafnium, meteorite samples, and mineral samples. Results are given for various samples. (M.C.G.)

4079 ROUTINE DETERMINATION OF PLUTONIUM BY TRACER TECHNIQUES IN LARGE BIOLOGICAL SAMPLES. W. J. Major, R. A. Wessman, R. Melgard, and L. Leventhal (Tracerlab, Inc., Richmond, Calif.). Health Phys., 10: 957-65(Dec. 1964).

A precision tracer procedure was developed for the rapid analysis of nonuniformly distributed plutonium in large biological samples. Liver, lung, kidney, lymph node, trachea, gastrointestinal tract, nasal mucosa, pharyngeal mucosa, bone, urine, and feces samples from burros, sheep, and dogs (exposed to plutonium aerosols) were assayed for plutonium. The chemical procedure consisted of: equilibration of sample plutonium with ^{236}Pu tracer, wet ashing by refluxing with H_2SO_4 and a catalyst, extraction of plutonium from bulk salts with cupferron–chloroform, purification with ion-exchange resins, and electro-deposition on platinum. These procedures minimized the requisite volume of acids and avoided the violent exothermic reactions of some wet ashing procedures. Problems associated with dry ashing, such as loss of the radioisotope by entrainment in solid carbon particles and formation of insoluble oxides of plutonium, were avoided. Also, the need for the large ashing furnaces was obviated. The plutonium content was measured by tracer yielding and alpha pulse-height analysis. This method ensured a high degree of accuracy, high sensitivity, and freedom from interference from other alpha emitters. A typical chemical yield was 55% and the counting precision was within 3%. Limits of detection were approximately 0.05 dis/min for a thousand minute count. (auth)

4080 MEASURING BORON BY THE NEUTRON METHOD IN OUTCROPS AND MINE WORKINGS. V. I. Baranov, V. K. Khristianov, B. V. Karasev, and G. I. Panov. Izv. Acad. Nauk SSSR, Ser. Geofiz., No. 3, 349-53 (1964).

A portable instrument used for boron detection and measurement by neutron bombardment is described, and results of field tests are furnished. To make the instrument portable, it was necessary to reduce the weight of current devices and, consequently, to reduce the power of the neutron source. The neutron retarder and reflector were combined in a single block. Sondes near the inversion value were employed, and this required a minimal length of 40 cm. Shorter sondes were too insensitive. The first instrument constructed weighed 16.5 kg and was tested in the field in 1960. A later model weighs but 8 kg. The instrument has three parts: a retarder-reflector of 5-liter capacity, immersed in water; a casette with two SNMO-5 counters in a P-shaped boron-cadmium shield; and a panel with amplifier, discriminator, transmitter, actuator, generator, and rate counter. Sensitivity was found to be 0.01% B_2O_3 for a 10% decline in counter rate. Results on surface rocks and in mine workings show the instrument to be satisfactory for rapid determination of boron mineralization without selection of rock samples. Results of profiling and of laboratory tests on the areas investigated were in good agreement. The instrument is suitable for exposed or slightly covered rocks. Either continuous or isolated readings may be made, and work may be carried out rapidly, permitting large areas to be covered quickly. (OTS)

4081 DETERMINATION OF TRACE ELEMENTS IN DRUGS BY NEUTRON ACTIVATION ANALYSIS. M. M. Tuckerman, L. C. Bate, and G. W. Leddicotte (Oak Ridge National Lab., Tenn.). J. Pharm. Sci., 53: 983-4(Aug. 1964).

An investigation of trace elements in drugs was undertaken to collect data for recommendations for tests for trace contaminants. Nondestructive neutron activation analysis was chosen as a rapid method that provided adequate sensitivity for all toxic elements and all common contaminants (except lead). Samples (100-mg) were irradiated in the neutron flux available in the air-cooled portion of the Oak Ridge graphite-moderated reactor. The energies of the emitted γ rays provided a characteristic of each isotope for qualitative identification. Quantitative measurement was made either by comparison of the sample with a standard or by mathematical calculation based upon a knowledge of the irradiating neutron flux and the geometry and efficiency of the γ-ray detector. Solid samples in glass vials were irradiated for appropriate periods, from a few hours to one week, in the air-cooled hole of the X-10 graphite-moderated reactor. After irradiation, samples were weighed and counted. The spectra obtained were analyzed by manual spectrum stripping using liquid standards of known concentrations irradiated simultaneously with the sample. Analysis of a large number of drug samples showed the frequent occurrence of bromine, which may indicate the presence of brominated intermediates, bromine in raw materials, or bromine in the plant atmosphere. Wide differences in sodium content for groups of samples of acetophenetidin, acetylsalicylic acid, methyl salicylate, and talc clearly indicated the origin of samples from different manufacturers. Copper was found in a grossly discolored portion of a sample of ascorbic acid, emphasizing the need for care in the manufacture of this substance. The occurrence of arsenic, antimony, and mercury in some samples,

although in quantities that would not be detected by the U.S.P. heavy metals test, showed the possibility of contamination and the need for retention of the U.S.P. test. (BBB)

4082 DIFFERENTIATING WATER AND PETROLEUM BY MEANS OF A SIMPLE NEUTRON-SPECTROMETRIC METHOD. E. Fritzsch and J. Kloeber (Physikalisches Institut der Bergakademie, Freiberg i. B.). Kernenergie, 7: 620-2(Aug. 1964). (In German)

An experimental study was carried out on the possibility of differentiating fresh water from oil by fast neutron scattering. From the pulse-height distributions measured by means of a scintillation measuring equipment using a Po–Be source and a ZnS-paraffin scintillator, the spectra of fast neutrons were approximately calculated. The differences between the spectra of oil and water were about 5%. (P.C.H.)

4083 METHOD FOR DETERMINATION OF ^{90}Sr IN MILK WITH TTA. Dante Ongaro and Giovanni Giulio Calapaj (Università, Padua). Minerva Nucl., 8: 273-8 (Sept.-Oct. 1964). (In Italian)

The use of an organic compound, the thenoyltrifluoroacetone (TTA), which, in determined conditions, is able to complex the Y and several rare earths, is proposed to simplify the assaying of ^{90}Sr in the fresh milk. The method follows in its initial stage the ion exchange technique previously described. The milk is poured in a container together with Sr carrier and about 350 cc of the Kastel C 300 cation exchange resin in H form, mixed and then eluted in column with 4.8N hydrochloric acid. From the eluate, which contains all cations of milk as chlorides, ^{90}Y is extracted, after having removed the ^{140}Ba, by complexing it, at a given pH, with a benzolic solution of TTA. The complex is then broken by action of nitric acid and the ^{90}Y is precipitated and brought to beta counting as oxalate. The method avoids the usual troublesome, time consuming Sr–Ca separation through repeated nitric precipitations and appears therefore particularly suitable for routine determinations. (auth)

4084 A SIMPLIFIED SCINTILLATION-COUNTING TECHNIQUE FOR ASSAYING $^{14}CO_2$ IN A WARBURG FLASK. H. J. Yardley (Univ. of Birmingham, Eng.). Nature, 204: 281(Oct. 17, 1964).

The $^{14}CO_2$ in a Warburg flask is assayed by trapping with filter paper moistened with KOH. The KOH is then placed in a solvent that will accommodate up to 3% of a 25% KOH solution with only 3% quenching. The activity in the solution is measured using a liquid scintillation counter. The method is applicable for CO_2 volumes up to 0.2 n liter. (T.F.H.)

4085 ON THE INTERFERENCE OF THE THRESHOLD REACTION ON THE ACTIVATION ANALYSIS BY (n,γ) REACTION. Eiji Shikata (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 6: 579-82 (Oct. 1964). (In Japanese)

In the case of activation analysis of trace amounts of sodium in magnesium or aluminum, of copper in zinc, and nickel in copper by (n,γ) reaction with thermal neutrons, such threshold reactions as (n,p) or (n,α) reaction on the major component elements with fast neutrons produce the radioisotopes of the same kinds as those produced by (n,γ) reaction on the minute component elements, and the results of the activation analysis of these minute components are affected more or less by the threshold reactions depending on the thermal and fast neutron flux distribution. In order to estimate the extent of the effect of the threshold reaction on the activation analysis, pure materials of the elements were irradiated in JRR-1 and -2 reactors together with sodium, copper, and nickel. The amounts of the radioisotopes produced by the threshold reactions were determined and compared with those produced by the corresponding (n,γ) reactions. By the irradiation in No. 1 experimental hole of JRR-1, which had relatively high fast neutron flux, the threshold reaction on the major component elements produced the radioisotopes, in amounts corresponding to several thousands ppm of the minute component elements. The apparent content of the minute component was still above 100 ppm even by the irradiation in No. 3 experimental hole of JRR-1, which had low fast neutron flux. (auth)

4086 MEASUREMENTS OF THE CONCENTRATION OF SHORT-LIVED DAUGHTER PRODUCTS OF RADON AND THORON IN AIR. Jan Flattau. Prace Central. Inst. Ochrony Pracy, 14: 95-113(1964). (In Polish)

A new method for measuring the concentration of airborne daughter products of radon and thoron, assuming that a radioactive equilibrium exists in the air, is described. The method is based on counting, within two time periods of sufficiently long duration, the alpha decays on the filter through which the air to be examined had previously been passed. Using this method, the content of daughter products of radon and thoron in both the air of a laboratory room and the outside air were determined. (auth)

4087 SIMULTANEOUS DETERMINATION OF TRACE AMOUNTS OF ZIRCONIUM AND TITANIUM. J. O. Hibbits, A. F. Rosenberg, and R. T. Williams (General Electric Co., Cincinnati). Talanta, 11: 1509-19(Nov. 1964).

A method is described for the determination of trace amounts of zirconium and titanium. The two elements are separated from the sample matrix by precipitation with cupferron using iron as a carrier. Zirconium is determined after extraction with TOPO (tri-n-octylphosphine oxide), by colorimetric measurement of the zirconium–Pyrocatechol Violet complex. Titanium is determined by colorimetric measurement of its thiocyanate complex extracted with TOPO. The method is accurate to within ±5% (relative) or ±2.5 μg, whichever is greater, for both elements. Using the modifications suggested, the method is nearly specific for the determination of titanium (milligram amounts of niobium cause slightly high results), and only thorium and hafnium interfere with the determination of zirconium. (auth)

4088 APPLICATIONS OF PRECIPITATE MEMBRANES IN ANALYTICAL CHEMISTRY. T. Braun (Lorand Eötvös Univ., Budapest) and J. Toelgyessy. Talanta, 11: 1543-4(Nov. 1964).

The need for separation of a precipitate in the indirect colorimetric determination of anions with the aid of sparingly soluble metal chloranilates, in radiometric titrations using solid precipitate indicators, and in procedures involving radioactive precipitate exchange, was eliminated by the use of precipitate membranes. (auth)

4089 CONTRIBUTIONS TO THE BASIC PROBLEMS OF COMPLEXOMETRY. XVI. DETERMINATION OF THORIUM AND SCANDIUM IN THE PRESENCE OF EACH OTHER. Rudolf Pribil and Vladimir Vesely (Polarographic Inst., Czechoslovak Academy of Sciences, Prague). Talanta, 11: 1545-8(Nov. 1964).

The titrimetric determination of thorium and scandium in the presence of each other is described. It is based on complexometric determination of their sum with EDTA at pH 2.5–3.5 using xylenol orange as indicator. After the addition of an excess of TTHA (triethylenetetraminehexaacetic acid) and adjustment of the pH to 5–5.5, the following displacement reaction then takes place: Th–EDTA + TTHA → Th–TTHA + EDTA while the Sc–EDTA complex remains unchanged. The liberated EDTA and excess of TTHA are determined by titration with a solution of zinc, which forms 1:1 and 2:1 complexes with EDTA and TTHA, respectively. From the consumption of zinc solution the amount of thorium is calculated. (auth)

4090 RADIOCHEMICAL SEPARATION OF COBALT BY ISOTOPIC EXCHANGE. Iqbal H. Qureshi (Atomic Energy Centre, Lahore). Talanta, 11: 1550-3(Nov. 1964).

The radiochemical separation of Co by an isotopic exchange technique was evaluated for an aqueous 0.5M oxalic acid system. The optimized procedure requires 6 min for the entire separation and gives cobalt yields of more than 83%. The specificity of the method was checked with the available tracers of 11 different elements. Mineral acids and aqueous ammonia interfere in the separation. This

procedure may find useful applications in the separation of short-lived isotopes of Co and is adaptable to remote handling. (auth)

4091 FLUORESCENT DETERMINATION OF MICROQUANTITIES OF EUROPIUM. N. S. Poluektov, R. A. Vitkun, and L. I. Kononenko (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 30: 629-35(1964). (In Russian)

Microquantities of Eu were determined by measuring the fluorescence of a suspension of rare earth phenanthroline-atophan complexes. The sensitivity of the method is 0.001 to 0.2 Eu_2O_3 in 5 ml of solution, depending on the other elements. The highest sensitivity was found in the presence of La, Gd, Tb, and Y in which it was possible to determine a Eu content of 5 to 10×10^{-4}%. The sensitivity in the presence of other rare earths is 0.02 to 0.1%. (R.V.J.)

4092 USE OF X-RAY FLUORESCENCE IN QUANTITATIVE DETERMINATION OF HIGHLY SINTERED CERIUM TITANATE. H. Nickel and H. J. Stoecker (Kernforschungsanlage, Julich, Ger.). Z. Anal. Chem., 206: 95-105(1964). (In German)

The possible application of x-ray fluorescence analysis to the determination of cerium and titanium in cerium titanates was investigated. Results of theoretical and experimental work show that, owing to the interelemental excitation, a quantitative analysis of the sintered samples over a wide concentration range is possible only when the borax flux method is used. For this reason major emphasis was given to the preparation of sound and stable molten samples. A special mold was developed for this. The experimental results are discussed in terms of error-analysis with special emphasis on the influence of statistical and calibration errors in the goniometer. (auth)

4093 CONDUCTOMETRIC DETERMINATION OF CERIUM(III) AS METAVANADATE. Sarju Prasad and Ramesh Chandra Srivastava (Banaras Hindu Univ., Varanasi, India). Z. Anal. Chem., 206: 171-4(1964).

Conductometric determination of Ce^{3+} was carried out successfully at 30 ± 0.5°C by titrating it against standard sodium metavanadate solution in 15% ethanol. An overall effect of ethanol concentration on the results was also studied. The titration curves obtained show a sharp break at the end point and lend support to the formation of $Ce(VO_3)_3$. The method has the advantage of being a simple and precise titrimetric procedure for the determination of Ce^{3+} in microquantities. (auth)

4094 AN X-RAY MICROANALYZER FOR ELEMENTS OF LOW ATOMIC NUMBER. Ray M. Dolby. p.483-93 of "X-Ray Optics and X-Ray Microanalysis." New York, Academic Press, 1963.

Method for the x-ray microanalysis of low atomic number elements using a proportional counter, a conventional scanning microanalyzer and a pulse analysis technique is described. A scanning microanalyzer designed for low atomic number elements is also described. The network pulse analysis method is used along with the microanalysis method to determine oxidation, carburization, and inclusions in U, Al, and Be. (Rev. Metal Lit., 21: No. 11, Nov. 1964).

4095 ANALYSIS OF HEAVY ELEMENTS (Z > 80) WITH THE CASTAING MICROPROBE: APPLICATION TO THE ANALYSIS OF BINARY SYSTEMS CONTAINING URANIUM. A. Kirianenko, F. Maurice, D. Calais, and Y. Adda. p.559-76 of "X-Ray Optics and X-Ray Microanalysis." New York, Academic Press, 1963. (In French)

Physical data were determined in order to apply the Castaing theory to high Z elements (Z > 80). The analysis of uranium in the binary system U–M, where M is any element of the periodic table, was taken as an example; ten different systems were studied experimentally. The results obtained allow the analysis of pure elements only without any calibration of alloys. (TCO)

4096 DETERMINATION OF VERY SMALL AMOUNTS OF TANTALUM IN NIOBIUM BY USING NEUTRON ACTIVATION AND GAMMA SPECTROSCOPY. F. Dugain (Pechiney Co., Grenoble, France) and J. Laverlochere. 14p. (CONF-151-5)

From 19th International Union of Pure and Applied Chemistry Congress, London, June 1963.

A simple and accurate method for the routine determination of tantalum in niobium and niobium oxide is described. The neutron activation method has the advantage of being extremely sensitive and selective, owing to the very different characteristics of the two radioisotopes produced: ^{94}Nb and ^{182}Ta. The main effort was centered on the interferences that arise in the case of ^{182}Ta, the radiochemical separation processes which would avoid these interferences, the limits of destructive and nondestructive methods, and the accuracy obtained. The results are used in industrial analysis. The sensitivity is excellent, even for an irradiation of only one hour in a flux of 10^{12} n · cm^{-2} · s^{-1}. (auth)

4097 IMPROVEMENTS IN OR RELATING TO RADIOMETRIC DETECTION OF NON-RADIOACTIVE MATERIALS. (to Australian Atomic Energy Commission). British Patent 968,749. Sept. 2, 1964. Priority date June 30, 1961, Australia.

A method for detecting and determining a non-radioactive material is described which is based on the formation of a radioactive precipitate. The method comprises impregnating a local region of a porous medium (e.g., filter paper or cloth) with a solution of the material, treating the impregnated region with a solution of radioactive substance which forms a radioactive precipitate with the material, washing the region to remove unreacted radioactive solution, and passing the porous medium to a radiation detector. Solutions of known concentrations of the material may be used to calibrate the method, which is of special applicability to the detection of beryllium and other toxic dusts in the atmosphere. Examples of the method are given in which beryllium is detected by reactions with ^{32}P-labeled diammonium phosphate, chloride is detected by reaction with ^{110}Ag-labeled silver nitrate, and fluoride is detected by reaction with a ^{144}Ce-labeled cerous solution. (D.L.C.)

4098 HIGH-FREQUENCY MASS SPECTROMETER TUBE AND CIRCUIT FOR THE OPERATION OF THE TUBE. Jans-Juergen Schuetze, Josef Ruf, and Heinz-Wilhelm Ehlbeck (to Telefunken Patentverwaltungsgesellshaft mbH). German Patent 1,171,879. June 25, 1964. Filed Mar. 12, 1960.

The tube consists of an ion source in coaxial alignment with an equidistant grid system and an ion collector. The tolerance of the grid system is chosen smaller than 2%, preferably smaller than 1%. The high-frequency amplitude for acceleration of the ions is chosen in such a way that the ratio $2N\ U/U_0 = 5$; N is the number of steps of the separation system, U is the peak value of the high-frequency voltage, and U_0 is the direct voltage of the ions entering the separation system. Two grid systems are established by connecting grids that are not immediate neighbors and feeding the high-frequency voltage into the two grid systems in counter-contact. (Gmelin Inst.)

4099 HIGH-FREQUENCY MASS SPECTROMETER. Josef Ruf (to Telefunken Patentverwertungsgesellschaft mbH). German Patent 1,175,466. Aug. 6, 1964. Filed Apr. 29, 1961.

The mass spectrometer system comprises an ion source, a high-frequency separator, and an ion collector. All the electrical connections are passed through a single glass plate, which is located near the collector system. Attached to the glass plate is a metallic flange. This flange is screwed onto the vacuum container so that the electrode system protrudes into the vacuum. As all the electrodes are mounted on insulating rods the space between the electrodes communicates freely with the surrounding gas volume. (Gmelin Inst.)

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Refer also to abstracts 4287, 4898, 4899, and 5019.

4100 (AD-450678) MASS SPECTROMETRIC STUDY OF ZIRCONIUM DIBORIDE. Technical Report No. C-25. O. C. Trulson and H. W. Goldstein (Union Carbide Corp.

Research Inst., Tarrytown, N. Y.). Oct. 1964. Contract DA-30-069-ORD-2787. 22p.

A mass spectrometer has been used with a high-temperature Knudsen effusion source to obtain vapor pressure data for zirconium diboride in the temperature range 2267 to 2445°K. The heat of vaporization at 298°K determined from a Third-Law analysis of the data is $\Delta H^{v}_{298} = 474.5 \pm 5.3$ kcal/mole. Vapor pressure data for zirconium and boron were also obtained: the Third-Law heats of vaporization are $\Delta H^{v}_{298} = 141.8 \pm 3.3$ kcal/mole for zirconium, and $\Delta H^{v}_{298} = 130.3 \pm 3.3$ kcal/mole for boron. The corresponding heat of formation of zirconium diboride at 298°K is $\Delta H^{f}_{298} = -72.1$ kcal/mole. Separate vapor-pressure measurements made on ZrB_2 mixed with C in a graphite crucible gave the result $\Delta H^{f}_{298} = -74.5$ kcal/mole. (auth)

4101 (CEA-R-2429) ETUDE CINÉTIQUE DE LA RÉACTION SUR L'URANIUM DE DIFFERENTS GAZ CARBONES. (Kinetic Study of the Reaction of Uranium With Various Carbon-Containing Gases). Guy Feron (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1964. 56p. Dep.(mn).

Thesis submitted to Université, Grenoble, France.

The kinetic study of the reaction $U + CO_2$ and $U + CO$ has been performed by a thermogravimetric method on a spherical uranium powder, in temperature ranges respectively from 460 to 690°C, and from 570 to 850°C. The reaction with carbon dioxide leads to uranium dioxide. A carbon deposition takes place at the same time. The global reaction is the result of two reactions: $U + 2CO_2 \rightarrow UO_2 + 2CO$ and $U + CO_2 \rightarrow UO_2 + C$. The reaction with carbon monoxide leads to a mixture of dioxide UO_2, dicarbide UC_2, and free carbon. The main reaction can be written: $U + CO \rightarrow \frac{1}{2}UO_2 + \frac{1}{2}UC_2$. The free carbon results from the disproportionation of the carbon monoxide. A remarkable separation of the two phases UO_2 and UC_2 can be observed. A mechanism accounting for the phenomenon has been proposed. The two reactions $U + CO_2$ and $U + CO$ begin with a long germination period, after which, the reaction velocity seems to be limited in both cases by the ionic diffusion of oxygen through the uranium dioxide. (auth)

4102 (CONF-571-15) ABSORPTION SPECTRA OF ALKALI METAL TELLURIDES IN MOLTEN ALKALI HALIDES. D. M. Gruen, R. L. McBeth, M. S. Foster, and C. E. Crouthamel (Argonne National Lab., Ill.). [nd]. Contract W-31-109-eng-38. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Absorption spectra are reported for the following mixtures and temperatures: Li_2Te in LiCl–KCl eutectic at 400 to 1000°C, Li_2Te in LiCl–LiF at 525°C, Li_2Te in CsCl at 700°C, and Cs_2Te in CsCl at 700°C. It is suggested that the ionization $Li_2Te \rightarrow LiTe^- + Li^+$ occurs, and that the spectra are due to the $LiTe^-$ species. The cell and furnace used in the study are described. (D.L.C.)

4103 (EURAEC-1129(Pt.2)) A STUDY OF SOME METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Final Report, Second Part. (Brussels. Université). [1964]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 081-62-5(RDB). 32p. Dep.(mn); $2.00(cy), 2(mn) OTS.

A study was made to explore the possibility of using the impedance bridge method to survey oxidized metallic surfaces. Equipment were developed for eliminating the effect of contamination, for studying the capacitive behavior of anodically oxidized and nonoxidized electrodes, and for determining the electricity balances associated with the electrode processes. Results are presented for Au and Pt electrodes in sulfate, perchlorate, and chloride solutions. (D.L.C.)

4104 (ORNL-3620) EQUILIBRIUM DISTRIBUTION OF METAL-ION COMPLEXES. Gerald Goldstein (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 51p. Dep.; $3.00(cy), 1(mn) OTS.

Data for the formation of metal complexes with inorganic ligands are compiled as distribution diagrams (fraction of each species present vs ligand concentration). The necessary computation and plotting were done by the CDC-1604 computer. A total of 138 diagrams are presented for metal complexes with fluoride, chloride, bromide, iodide, ammonia, sulfate, nitrate, thiocyanate, thiosulfate, and cyanide. Diagrams have been made only for those cases in which at least three species were present. Plots have also been made for the dissociation of some common polyprotic acids (species present as a function of pH). (auth)

4105 (ORNL-3627(p.224-30)) HIGH-TEMPERATURE CHEMISTRY. (Oak Ridge National Lab., Tenn.).

A program to develop and exploit various spectrophotometric techniques for studying the properties of aqueous solutions, primarily of uranium, transuranium, rare-earth, and transition-group elements is described. The principal effort is directed at construction of a spectrophotometer that can be used to study spectra of these elements in solutions up to 330°C. To aid in characterizing these solutions, a special autoclave was built for measuring liquid densities at high temperatures and pressures. Since the high-temperature spectrophotometer has not been constructed, preliminary spectral studies of UO_2^{2+} and Pu^{4+} ions were made up to 95°C in existing spectrophotometers equipped with punched-card outputs. Computer codes for the IBM 7090 were written for calculating reaction rates from spectral data taken as a function of time and for resolving complex spectra into individual absorption peaks. Work continued on the development of equipment and techniques for studying aqueous solutions at high temperatures and pressures. The prototype high-temperature, high-pressure spectrophotometric absorption cell performed satisfactorily in tests at temperatures up to 350°C and pressures to 3400 psi, applied simultaneously. A series of absorption measurements was made of uranyl perchlorate solutions of fixed ionic strength at U concentrations between 0.01 and 0.75 M and at acidities from 3 M $HClO_4$ to solutions having hydroxyl numbers of about 1.0 at 25 to 95°C. As the acidity is lowered through the stoichiometric point into the region where the uranyl ion becomes progressively more hydrolyzed, significant spectral changes are observed. As the acidity is lowered, the effect of increased temperature in promoting hydrolysis becomes increasingly more pronounced. The first phase of the analysis of the data from studies of the polymerization, precipitation, and depolymerization behavior of Pu(IV) in nitrate systems at 25 to 95°C was completed. Calculations were made of the rates of the polymerization and depolymerization reactions. Enough data were analyzed to permit the formation of three-dimensional surfaces interrelating the rates and extent of depolymerization and the HNO_3 concentration up to 15 M HNO_3. The effects of several complexing agents on the depolymerization rate were determined. The generalized computer program developed to obtain reaction rate data by the analysis of spectrophotometric absorption data from dynamic multicomponent systems is operating on the IBM 7090. (auth)

4106 (ORNL-3667) DEVELOPMENT AND USE OF A PROCESS FOR CRYSTALLIZATION OF CESIUM TETRAOXALATE: AN INTERMEDIATE FOR PREPARING ^{137}Cs SOURCE COMPOUNDS. R. E. Lewis (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 21p. Dep.; $2.00(cy), 1(mn) OTS.

A process was developed for crystallization of cesium tetraoxalate, $CsH_3(C_2O_4)_2 \cdot 2H_2O$. Addition of oxalic acid to cesium-rich solutions precipitates more than 90% of the cesium as the tetraoxalate under optimum conditions. Cesium alum is converted to cesium tetraoxalate in 70% yield with cocrystallization of <1% aluminum. Cesium remaining in solution is recycled, giving low process losses. The oxalate was demonstrated to be sufficiently stable to radiation to be useful as an intermediate in processing fission-product ^{137}Cs. Cesium tetraoxalate is calcined at 450°C to cesium carbonate, which is readily converted to cesium salts or glasses. The process has been used since Jan. 1, 1963, at the Fission Products

Development Laboratory, ORNL, for preparing thousand-curie batches of ^{137}Cs chloride and glasses. (auth)

4107 (ORNL-TM-968) EQUILIBRIUM CONSTANTS AND CONCENTRATIONS IN THE REACTIONS OF NITROGEN AND OXYGEN AT 400° TO 5000°K. E. Schonfeld (Oak Ridge National Lab., Tenn.). Oct. 5, 1964. Contract W-7405-eng-26. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The efficiencies of the reaction of nitrogen with oxygen to form NO at high temperatures and the further oxidation of NO into NO_2 at low temperatures were calculated as a function of the initial gas composition, temperature, and pressure. The calculations were made by using the equilibrium constants for the seven reactions considered and by use of iterative numerical methods. The highest yield for NO was obtained with a gas mixture containing 50% N_2 and 50% O_2. The NO yield was proportional to the pressure. The yield increased as a function of temperature and passed through a maximum. At 10 atm the maximum NO yield from air was 7.6% at 3800°C, and, for an equal mixture of N_2 and O_2, it was 11.0% at 4000°C. At the lowest temperature studied, 127°C, the conversion of NO into NO_2 is nearly complete. (auth)

4108 (SC-R-64-138) ERBIUM—A SELECTIVE BIBLIOGRAPHY OF RARE EARTH REFERENCES. Jean P. Naughton (Sandia Corp., Albuquerque, N. Mex.). July 1963. Contract AT(29-1)-789. 41p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A total of 186 references, some in abstract form, are presented on erbium. Among the topics covered are preparation and properties, separation techniques, analytical chemistry, and radiochemistry. (D.L.C.)

4109 (SC-RR-64-1256) NONELECTROSTATIC SOLVENT EFFECTS IN CHEMICAL KINETICS. James O. Wear (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract AT(29-1)-789. 32p. Dep.; $2.00(cy), 1(mn) OTS.

The nonelectrostatic solvent effects have been studied extensively by comparison of data and theory. Unless there are specific solvent effects, it has been shown that for a reaction that can be studied in both the gas phase and the liquid phase, the solvent affects the reaction only slightly. Solvents such as carbon tetrachloride have been found, generally, to give the same rates as observed in the gas phase. The predictions of absolute rate theory for solvent effect have been examined, and it has been observed that the relation $k(solution)/k(gas) = e^{E\sigma/RT}$ fits the data best. For reactions that take place only in solution, various nonelectrostatic effects have been studied. The rules for predicting change of rate because of the effect of cohesion or internal pressure have been found to have little use. The effect of viscosity has been found to be fairly valid, but when the viscosity is changed by raising the temperature the calculated rate is off by a factor of 2.5. Both the solvation effects, when separable from other effects, and the cage effect, particularly as it applies to photochemical reactions, are discussed. (auth)

4110 (AI-Trans-62) SOLUBILITY OF BISMUTH IN FUSED BISMUTH CHLORIDE. Yu. K. Delimarskii (Delimarsky) and Yu. G. Roms. Translated for Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif., from Ukr. Khim. Zh., 30: 457-60(1964). 11p. Dep.(mn); $1.00(cy) 1(mn) OTS; $1.10(fs), $0.80(mf) JCL.

The nature of solution of bismuth in bismuth trichloride was studied at 400°C. An assumption was made about the presence of Bi_2^{3+} ions in such fused salts. (auth)

4111 (ORNL-tr-316) HEAT AND MASS TRANSFER. VOLUME I. THERMOPHYSICAL CHARACTERISTICS OF MATERIALS AND METHODS FOR THEIR DETERMINATION. OPTICAL METHOD FOR MEASURING RECIPROCAL DIFFUSION COEFFICIENTS OF GASES. P. E. Suetin. Translated by A. L. Monks (Oak Ridge National Lab., Tenn.), from Teplo i Massoperenos, Pervoe Vses. Soveshch., Minsk, 1961, 1: 188-90(Pub. 1962). 7p. Dep.(mn); $1.00 (cy) 1(mn) OTS; $1.10(fs), $0.80(mn) JCL.

A diffusion apparatus for measuring reciprocal diffusion coefficients of gases is described. The optical system consists in a light source, diffusion tubes, photomultiplier, and collimators and screens, and a vacuum system is included for degassing. High-precision results were obtained for various gas pairs. (R.E.U.)

4112 NOTE ON THE CRYSTALLOGRAPHY OF Eu_2SiO_4. Robert C. Rau (General Electric Co., Cincinnati). Acta Cryst., 17: 1483-4(Nov. 10, 1964).

Single crystal x-ray data were used to determine the lattice parameters and index the powder pattern for Eu_2SiO_4. From the data, Eu_2SiO_4 appears to have a very unusual crystal structure, the long b axis being of particular interest. It is believed that the structure of Eu_2SiO_4 may be layered along the b axis, with the layering, and hence the true b parameter, repeating every seven layers. Such a structure would contain 4 formula units of Eu_2SiO_4 in each pseudo-cell layer, and 28 units in the complete unit cell. This leads to a theoretical density of 6.77 $g \cdot cm^{-3}$. Petrographic analyses of the orange-yellow crystals showed Eu_2SiO_4 to be biaxial positive, having an optic angle 2V = 25° and refractive indexes $N_x = 1.89$ and $N_z = 1.92$. N_y is approximately 1.90. (P.C.H.)

4113 HEATS OF FORMATION OF ZIRCONIUM HYDRIDES. A. G. Turnbull (Commonwealth Scientific and Industrial Research Organization, Melbourne). Australian J. Chem., 17: 1063-71(Oct. 1964).

Heats of solution in 3.83N HF were measured for zirconium metal and for five zirconium hydrides to evaluate the following heats of formation ΔH^0_{298}: ZrH_2—39.7, $ZrH_{1.85}$—38.2, $ZrH_{1.70}$—34.7, $ZrH_{1.43}$—30.05, and $ZrH_{1.23}$—25.3 kcal/mole hydride. A review of heat capacity and entropy data for zirconium hydrides enabled a good correlation to be made between calorimetric and dissociation pressure studies, so that the effect of composition on all thermodynamic properties was established. (auth)

4114 THE POLAROGRAPHY OF BERYLLIUM. P. J. Shirvington (Australian Atomic Energy Commission, Lucas Heights, New South Wales), T. M. Florence, and A. J. Harle. Australian J. Chem., 17: 1072-84(Oct. 1964).

The polarography of beryllium in 0.5M lithium chloride was investigated in detail, using several polarographic and coulometric techniques. Current-time curves, microscopic examination, and cinematography of the mercury drop, and the effect of complexing agents, aided in elucidating the electrode process. The experimental data show that the polarographic step for the tetraquoberyllium ion is diffusion-controlled but irreversible, and results from the reduction of two protons liberated from the coordinated water molecules, yielding beryllium hydroxide and hydrogen. The evidence suggests that this reduction takes place in a stepwise process, with a soluble beryllium hydroxy complex as an intermediate. The polarographic results can be correlated with published potentiometric data on the composition and stabilities of hydrolyzed beryllium species in aqueous media. The number of electrons involved in the electrode reaction depends on the number of hydroxyl groups per beryllium atom in the beryllium complex. Beryllium oxalate and salicylate complexes also give a reduction step, but only if the complex contains coordinated water molecules. The diffusion coefficient of the tetraquoberyllium ion was found to be $6.2 \pm 0.3 \times 10^{-6}$ $cm^2\ sec^{-1}$ at 30°. (auth)

4115 NUCLEAR MAGNETIC RESONANCE AND ELECTRONEGATIVITY. Jean-Claude Muller (Université, Nancy). Bull. Soc. Chim. France, No. 8, 1815-17(Aug. 1964). (In French)

A scale of electronegativity is proposed, based on NMR measurements made on substituted derivatives of ethane and ethylene. (tr-auth)

4116 STUDY OF THE IONIC SPECIES OF PROTACTINIUM IN AQUEOUS SOLUTION. I. HYDROLYSIS OF PENTAVALENT PROTACTINIUM. Robert Guillaumont and Georges Bouissieres (Université de Paris, Arcueil, France). Bull. Soc. Chim. France, No. 9, 2098-2103 (Sept. 1964). (In French)

The partition at 25°C of Pa^{5+} between $HClO_4$—$LiClO_4$ aqueous solutions with ionic force of 3 and benzene solutions of 2-thenoyltrifluoroacetone was studied. In 1 to 3N

perchloric medium, the dominant ion is $Pa(OH)_3^{3+}$ or $PaO(OH)^{2+}$. This ion seems to exist even in more acid solutions. When the acidity decreases, hydrolysis is responsible for the appearance of the species $Pa(OH)_4^+$ or PaO_2^+. (tr-auth)

4117 ABSORPTION SPECTRUM AND STABILITY OF PROTACTINIUM TETRAFLUORIDE IN NEUTRAL HYDROFLUORIC MEDIUM. Carlos Feirrera de Miranda and Roland Muxart (Université de Paris, Arcueil, France). Bull. Soc. Chim. France, No. 9, 2174-6(Sept. 1964). (In French)

The absorption spectra in the visible and ultraviolet was measured, and the stability of Pa(IV) in the neutral hydrofluoric medium was studied. The evolution of the spectrum with the age of the solution showed that Pa(IV) is oxidized by the solvent. The oxidation is of the first order with respect to the concentration of Pa(IV); it is catalyzed by daylight and more intensely by ultraviolet light. (tr-auth)

4118 ON THE CRYSTALLINE STRUCTURE OF RHENIUM DIOXIDE. Suzanne Tribalat, Marie-Louise Jungfleisch, and Denise Delafosse. Compt. Rend., 259: 2109-12(Sept. 28, 1964). (In French)

The two crystalline varieties of the dioxide studied appear to correspond to the same formula ReO_2, within the precision of the analysis made. The dioxide of monoclinic structure of the MoO_2 type which appears, mixed with amorphous oxides, during the incomplete thermolysis of the ammonium perrhenate can be obtained in the pure state by thermal treatment of the hydrated oxide. The orthorhombic variety can itself be prepared in pure form by dismutation of the oxide ReO_3, while it is the principal constituent of the oxide ReO_2 formed by thermolysis of the ammonium perrhenate. (tr-auth)

4119 PREPARATION OF MOLYBDATES OF LITHIUM, YTTRIUM; AND LANTHANUM. Philippe-Henri Hubert (Faculte des Sciences, Lyon). Compt. Rend., 259: 2238-40(Oct. 5, 1964). (In French)

The reactions of MoO_3 with Li_2O, Y_2O_3, and La_2O_3 were studied, and the characteristics of the product were determined. In the system Li_2O-MoO_3, one compound with the composition 1.9 MoO_3, Li_2O was found. In the $Y_2O_3-MoO_3$ system, formulas of Y_2O_3, MoO_3 or Y_2MoO_5 were found. The formula found in the La_2O_3 reaction was La_4MoO_8 or La_2O_3, 0.5 MoO_3. Lattice distances are tabulated for all compounds. All three compounds were oxidized in air to the molybdate. (J.S.R.)

4120 ANODIC DISSOLUTION OF LIQUID GALLIUM. T. Hurlen, T. Valand, and G. Lunde (Central Inst. for Industrial Research, Oslo). Electrochim. Acta, 9: 1433-7 (Nov. 1964).

The dissolution rate of liquid gallium, anodes in 1N solutions of hydrochloric acid, sulfuric acid, and sodium hydroxide at 30.5°C was measured radiochemically under galvanostatic condition (0 to 12 ma/cm^2). In the hydrochloric acid solution, the anodes consumed very nearly 2 F/g-atom gallium dissolved. In the two other solutions, the corresponding number was higher and approached 3 with increasing current. It was concluded that lower-valence gallium species are formed (at least as intermediates) in all three solutions. (auth)

4121 ANODIC DISSOLUTION OF LIQUID GALLIUM IN ACID CHLORIDE SOLUTIONS. T. Hurlen (Central Inst. for Industrial Research, Oslo). Electrochim. Acta, 9: 1439-47(Nov. 1964).

Steady-state and transient galvanostatic studies were made on the anodic dissolution of liquid gallium in pure and mixed solutions of hydrochloric acid and potassium chloride at 50°C. The results indicated that fast ion transfer is followed by rate-determining electron transfer (redox control), and was consistent with co-operative control by the two one-electron steps of the Ga(I)–Ga(III) redox reaction. The observed dissolution equivalent of about 2 F/g-atom probably indicated that association of Ga(I) with Ga(III) into chloride-stabilized Ga_2(IV) succeeds the electrode reactions. The dissolution process is second-order in chloride dependence. Comparisons were made with data in alkaline solutions. (auth)

4122 ANODIC DISSOLUTION OF LIQUID GALLIUM IN ALKALINE SOLUTIONS. T. Hurlen (Central Inst. for Industrial Research, Oslo). Electrochim. Acta, 9: 1449-52 (Nov. 1964).

The steady-state anodic dissolution of liquid gallium in pure and mixed solutions of sodium hydroxide and potassium chloride at 50°C was studied by a slow galvanostatic technique. With increasing current density, the Tafel slope increased from $^2/_5$ to $^2/_3$ of 2.303 RT/F, and the hydroxyl-ion interaction exponent simultaneously decreased from 4 to 3 or lower. The chloride ion had no specific effect on the active dissolution reaction in alkaline solutions. Comparisons were made with data in acid chloride solutions, and a reaction scheme is suggested. (auth)

4123 AEROSOL PRODUCTION AND CHARACTERIZATION: SOME CONSIDERATIONS FOR IMPROVING CORRELATION OF FIELD AND LABORATORY DERIVED DATA. T. T. Mercer (Lovelace Foundation for Medical Education and Research Albuquerque, N. Mex.). Health Phys., 10: 873-87(Dec. 1964).

A comparison of laboratory and field practices indicates that marked differences may occur between laboratory and field aerosols, and that differences in methods of characterization make comparable results difficult to achieve. A review of the electrical properties of aerosols show that the use of atomization, a favorite laboratory technique for producing aerosols, can lead to very high electrical mobilities, making reproducibility difficult and causing anomalous experimental results. The difficulties involved in extrapolating from a size frequency distribution to a distribution of activity as a function of aerodynamic diameters are discussed. The sampling properties of rectangular jet, single round jet, and multiple round jet impactors are summarized and approximate relationships are given on which to base the design of impactors for specific purposes. The sampling characteristics of the Conifuge and the aerosol spectrometer are also summarized. (auth)

4124 FABRICATION OF MONODISPERSE LUCITE AND IRON OXIDE PARTICLES WITH A SPINNING DISK GENERATOR. Roy E. Albert, Henry G. Petrow, Abdel S. Salam, and Jack R. Spiegelman (New York Univ., New York). Health Phys., 10: 933-40(Dec. 1964).

A technique for making radioactive lucite and iron oxide spheres in the range 1–8 μ, which have a minimum size uniformity of 10% standard deviation, is described. The method involves the atomization, with a spinning disk generator, of an iron oxide sol or lucite in a xylene–acetylacetone solution. Tagging of the particles is done by addition of the isotope either in carrier-free form to the sol or chelated with acetylacetone to the lucite solution. The assessment of leaching of a variety of isotopic tags from the particles is described. (auth)

4125 STUDIES ON THE THERMAL BEHAVIOUR OF URANIUM(IV) OXALATE. D. S. Bharadwaj and A. R. Vasudeva Murthy (Indian Inst. of Science, Bangalore). Indian J. Chem., 2: 391-6(Oct. 1964).

The thermal decomposition of uranium (IV) oxalate hexahydrate and dihydrate was studied by three different techniques; decomposition in vacuum; thermogravimetric analysis; and differential thermal analysis. The results indicate that decomposition is always preceded by dehydration, although the last stages of dehydration and commencement of decomposition cannot be demarcated. The products of decomposition in vacuum comprises carbon monoxide and carbon dioxide in the gaseous phase while the solid residue is a mixture of uranium dioxide and elemental carbon. The formation of a carbonate as an intermediate product of decomposition was confirmed by analyzing the residue left at different stages. When the decomposition is carried out in an atmosphere of air, nitrogen, or carbon dioxide, the oxide left behind corresponds to U_3O_8, confirmed by analysis and x-ray diffraction study. (auth)

4126 DIMETHYL SULPHOXIDE COMPLEX OF URANYL PERCHLORATE AND REARRANGEMENT OF BOND-

ING OF DMSO IN THE COMPLEX. V. Krishnan and C. C. Patel (Indian Inst. of Science, Bangalore). Indian J. Chem., 2: 416-17(Oct. 1964).

The dimethyl sulfoxide (DMSO) complex of uranyl perchlorate, $UO_2 \cdot 5DMSO(ClO_4)_2$, was prepared. It loses one lattice-held DMSO molecule at 170°C, yielding $UO_2 \cdot 4DMSO(ClO_4)_2$. The latter complex explodes at 330°C, the explosion temperature of $UO_2(ClO_4)_2$. The infrared spectrum of the penta-DMSO complex shows coordination between the metal and the DMSO by donation of a lone pair of electrons on oxygen of DMSO while in the tetra-DMSO complex, a rearrangement in bonding through sulfur of DMSO takes place. The electronic spectrum of the DMSO-complex in DMSO medium gives less number of bands than those of uranyl perchlorate in water, showing complex formation with DMSO. (auth)

4127 ACTION OF POTASSIUM PHOSPHATE ON THE MOBILITY OF ^{90}Sr ABSORBED IN THE SOIL. G. N. Tselishcheva. Izv. Timiryazev. Sel'skokhoz. Akad., No. 5, 121-9(1963). (In Russian)

Sorption of ^{90}Sr by neutral salt solutions, following strontium reaction with potassium phosphate, did not vary in natural soils or soils previously saturated with potassium or strontium. The duration of strontium reaction with potassium phosphate did not affect mobility in the soil; the index of ^{90}Sr sorption by neutral salts remained the same after one day and three months of ^{90}Sr reaction with potassium phosphate. The liquid: solid ratio did not influence the fixation of absorbed strontium. The obtained data do not support one postulation that reduced ^{90}Sr uptake by plants in phosphate rich soils is caused by chemical absorption, forming strontium phosphate, or by precipitation of strontium with potassium phosphate. (R.V.J.)

4128 HYDROGEN EXCHANGE OF AZULENES. IV. THE ACID-CATALYZED DETRITIATION OF AZULENE-1-t AND GUAIAZULENE-3-t. Robert J. Thomas and F. A. Long (Cornell Univ., Ithaca, N. Y.). J. Am. Chem. Soc., 86: 4770-3(Nov. 20, 1964).

The acid-catalyzed detritiation of azulene-1-t and guaiazulene-3-t was measured in dilute aqueous solutions for a number of general acid catalysts. For azulene-1-t, second-order rate coefficients were determined for a series of undissociated carboxylic acids, dicarboxylic acid monoanions, and anilinium ions, as well as for hydronium ion and water. For guaiazulene-3-t, second-order rate coefficients were determined for three undissociated carboxylic acids and for ammonium ion, biphosphate ion, hydronium ion, and water. In addition, thermodynamic ionization constants were determined for conjugate acids of azulene and guaiazulene. The rate data for both azulenes showed agreement with a linear Brønsted relation. However, more complete studies with azulene-1-t showed that there are separate Brønsted plots, with differing α-values, for the different classes of acid catalysts. The values for the Brønsted α-parameter exhibited by azulene were larger than that for guaiazulene, in accord with the fact that guaiazulene is the stronger base. (auth)

4129 RACEMIZATION AND RADIOCHLORIDE EXCHANGE OF p-CHLOROBENZHYDRYL CHLORIDE IN A SERIES OF SOLVENTS. Arthur F. Diaz and S. Winstein (Univ. of California, Los Angeles). J. Am. Chem. Soc., 86: 5010-11(Nov. 20, 1964).

Ion pair return during solvolysis causes the polarimetric rate constant, k_α, for formation of racemic starting material and product from p-chlorobenzhydryl chloride (RCl) to exceed the titrimetric rate constant, k_t. The value for k_α was much larger than the first-order radiochloride exchange rate constant, k_e, with low concentrations of added labeled LiCl. A striking solvent specificity was observed for (k_α/k_e) ratios. It was concluded that k_e is associated with ionization of RCl. (M.C.G.)

4130 RADIOCHLORINE EXCHANGE AND RACEMIZATION OF 1-PHENYLETHYL CHLORIDE AND p-METHYLBENZHYDRYL CHLORIDE IN NITROMETHANE. Y. Pocker, W. A. Mueller, Francesco Naso, and Giorgio Tocchi (University Coll., London and Univ. of Washington, Seattle). J. Am. Chem. Soc., 86: 5011-12(Nov. 20, 1964).

Radiochlorine exchange of 1-phenylethylchloride and p-methylbenzhydryl chloride in nitromethane was found to be a bimolecular process that proceeds with inversion of configuration. (M.C.G.)

4131 THE HYDROGEN CHLORIDE CATALYZED RADIOCHLORINE EXCHANGE AND RACEMIZATION OF ARALKYL CHLORIDES IN NITROMETHANE. Y. Pocker, W. A. Mueller, Francesco Naso, and Giorgio Tocchi (University Coll., London and Univ. of Washington, Seattle). J. Am. Chem. Soc., 86: 5012-13(Nov. 20, 1964).

Isotopic chlorine exchange between 1-phenylethyl chloride and labeled hydrogen chloride was studied over a reagent concentration of 0.03 to 0.11M in nitromethane. The rate constant was practically the same as that obtained for dehydrohalogenation in the presence of pyridine. It was concluded that the rate is controlled by the rate of production of chemically capturable 1-phenylethyl cations and that the energy barriers for $H^{36}Cl$ catalyzed racemization and exchange are the same. (M.C.G.)

4132 THE SECONDARY ISOTOPE EFFECT ON PROTON TRANSFER FROM THE HYDRONIUM ION IN AQUEOUS SOLUTION. A. J. Kresge and D. P. Onwood (Illinois Inst. of Tech., Chicago). J. Am. Chem. Soc., 86: 5014-16(Nov. 20, 1964). (TID-21265)

Examples of the deuterium isotope effect on proton transfer from the hydronium ion were measured and in no case was the value larger than 3. It was previously suggested that these low values are the result of an inverse secondary isotope effect. Tritium was used in experiments to measure this secondary effect. The rates of incorporation of tracer levels of tritium into a substrate from acidified solutions of H_2O and D_2O were measured. The ratio of the rate constants for these to reactions is the secondary isotope effect. The secondary isotope effect was found to be 0.60 ± 0.02, but it was concluded that its value will vary with conditions with a lower limit of 0.48. (M.C.G.)

4133 REACTIONS OF OLEFINS WITH XENON FLUORIDES. Tsu-chia Shieh (Chicago Univ.), N. C. Yang, and C. L. Chernick. J. Am. Chem. Soc., 86: 5021-2(Nov. 20, 1964).

Reactions of xenon fluorides with olefins are described. Products were identified by their infrared, nuclear magnetic resonance, and/or mass spectra. It was observed that XeF_6 is more reactive than XeF_4 while XeF_2 is less reactive. (M.C.G.)

4134 DENSITIES OF NEODYMIUM NITRATE–MOLTEN ALKALI NITRATES AND LITHIUM PERCHLORATE MIXTURES. J. Padova and J. Soriano (Israel Atomic Energy Commission, Yavne). J. Chem. Eng. Data, 9: 510(Oct. 1964).

The densities of mixtures of lithium perchlorate and $NaNO_3$–KNO_3 eutectic mixtures with or without neodymium nitrate were studied as a function of temperature, and the data fitted to the expression $d = a - bt$ by a least squares analysis. As a part of a general study of lanthanide–nitrate interaction in molten media, the densities needed to calculate molar absorbance from spectrophotometric measurements were determined. The medium used was the sodium–potassium nitrate eutectic with or without lithium perchlorate admixture. The densities were measured as a function of the concentration of neodymium nitrate and temperature over the range 230 to 400°C. (auth)

4135 GASEOUS DIFFUSION IN POROUS MEDIA. IV. THERMAL DIFFUSION. E. A. Mason (Univ. of Maryland, College Park) and A. P. Malinauskas. J. Chem. Phys., 41: 3815-19(Dec. 15, 1964). (IMP-AEC-31)

The pressure dependence of thermal diffusion is derived on the basis of the dusty-gas model, in which a porous medium is considered as a collection of giant molecules (dust particles) fixed in space. The results can also be applied to capillaries by suitable substitution for geometric parameters. Thermal separation is zero at zero pressure and constant at high pressures, but the transition can be quite complex and varied, depending upon the temperature, molecular masses, and intermolecular forces of the gas mole-

cules involved. Representative calculations were made to illustrate the possibility of maxima and sign reversals of the thermal separation as a function of pressure. Comparison with the scanty available experimental results revealed no discrepancies, but further experiments are desirable, particularly for cases in which unusual transition behavior is expected. (auth)

4136 ANALYSIS OF ISOTOPE EXCHANGE REACTIONS AMONG NITROGEN OXIDES INVOLVING N_2O_3. E. U. Monse, Lois Nash Kauder, and W. Spindel (Rutgers Univ., Newark, N. J. and Yeshiva Univ., New York). J. Chem. Phys., 41: 3898-3905(Dec. 15, 1964).

The fundamental frequencies of isotopic N_2O_3 molecules and equilibrium constants of isotope exchange reactions involving N_2O_3 were calculated from available spectroscopic data. The calculations were compared with observed fractionation factors for nitrogen isotope exchange between N_2O_3 and NO, reported previously, and with experimental fractionation factors for oxygen isotope exchange. The effect of phase changes on the isotopic equilibrium constant was estimated. (auth)

4137 ISOTOPE EFFECTS ON METASTABLE TRANSITIONS IN MASS SPECTRA. Marvin L. Vestal (William H. Johnston Labs., Inc., Baltimore). J. Chem. Phys., 41: 3997-8(Dec. 15, 1964).

Minimum rates for the decomposition of CD_4^+ and CHD_3^+ were computed by representing the molecular ions as a collection of harmonic oscillators and computing the density of states. The activation energy for the decomposition of both CD_4^+ and CHD_3^+ was assumed to be 1.2 ev as indicated by previous appearance potential measurements. Calculations of the minimum rates using the molecular frequencies gave minimum rates that would indicate that neither metastable transition should be observed. However, if the ionic frequencies are taken as one-third of the molecular frequencies, minimum rates are obtained that are consistent with observed effects. If the maximum rate contributing to the metastable peak lies between these two minimum rates, the metastable decomposition of CD_4^+ will be observable while the metastable decomposition of the partially deuterated and undeuterated methanes (occurring with higher minimum rates) will not. For both sets of frequencies the minimum rate for decomposition of CHD_3^+ is about twice that for decomposition of CD_4^+. (P.C.H.)

4138 DEUTERON MAGNETIC RESONANCE IN POLYCRYSTALLINE HEAVY ICE (D_2O). Jasper A. Jackson and Sherman W. Rabideau (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 41: 4008(Dec. 15, 1964). (LADC-6132)

The deuteron magnetic resonance from polycrystalline samples of heavy ice was studied in the temperature range −10 to −130°C. A theoretical analysis of the quadrupole splitting of the deuteron resonance in a polycrystalline sample of heavy ice predicted the occurrence of two main peaks with small shoulders symmetrically located on either side. The splitting results from the coupling of the electric quadrupole moment of the deuteron (spin I = 1) with the electric field gradient in the ice crystal. The measured splitting gave 192 ± 2.7 kc/sec for the quadrupole coupling constant. The absence of an observed temperature dependence of the D_2O splitting suggests that either the crystal is in a region where the average thermal energy of the deuteron is large compared with any barrier to the deuteron motion or that there is little or no motion of the deuterons. (P.C.H.)

4139 A CORRELATION BETWEEN VIBRATIONAL ISOTOPE SHIFTS AND MASS SPECTRAL FRAGMENTATION PATTERNS. Walter J. Lehmann (Univ. of California, Los Angeles). J. Phys. Chem., 68: 3188-91(Nov. 1964).

A very simple direct correlation between vibrational frequency shifts and mass spectral isotope effects for diatomic and quasi-diatomic molecules is suggested. (P.C.H.)

4140 SUBSTITUENT EFFECTS ON INTRAMOLECULAR ENERGY TRANSFER. II. FLUORESCENCE SPECTRA OF EUROPIUM AND TERBIUM β-DIKETONE CHELATES. N. Filipescu, W. F. Sager, and F. A. Serafin (George Washington Univ., Washington, D. C.). J. Phys. Chem., 68: 3324-46(Nov. 1964).

The fluorescence spectra of europium and terbium β-diketone chelates were modified significantly on changing substituents in the organic ligand. The relative intensity, spectral distribution, shifting, and splitting of the fluorescence lines are discussed in relation to the nature of substituents, their position, molecular configuration, and the overall intramolecular energy transfer. (auth)

4141 HEATS OF FORMATION OF SOME HEXAVALENT URANIUM COMPOUNDS. E. H. P. Cordfunke (Reactor Centrum Nederland, Petten, Netherlands). J. Phys. Chem., 68: 3353-6(Nov. 1964).

The heat of formation of the UO_2^{2+} ion was determined by measuring the heat of solution of γ-UO_3 in nitric acid calorimetrically. From the known heat of formation of γ-UO_3, the heat of formation of the UO_2^{2+} ion in 6 N HNO_3 was found to be: $-\Delta H_{298} = 242.2 \pm 1.0$ kcal/mole. This value was used for the determination of the heats of formation of the modifications of UO_3, the hydrates of UO_3, the hydrates of uranyl nitrate, and the uranates of ammonium by heat of solution measurements in nitric acid. (auth)

4142 THE GROUND STATES AND RELATIVE STARK SPLITTINGS OF SOME TRIVALENT RARE EARTH IONS IN THE CUBIC CRYSTAL FIELD OF CALCIUM FLUORIDE. U. Ranon (Israel Atomic Energy Commission, Yavne). J. Phys. Chem. Solids, 25: 1205-12(Nov. 1964). (IA-897)

The ratios B_4/B_6 of the cubic crystal field parameters are calculated from electron spin resonance on CaF_2; Nd^{3+} and CaF_2; Dy^{3+}, and the results are used to show that the ratio A_4/A_6 is not constant, as required by the point charge model. A linear expression of A_4/A_6 as a function of Z is constructed from the available data. The integrals $\langle r^4 \rangle$ and $\langle r^6 \rangle$ of Freeman and Watson are used in deducing B_4/B_6 for the trivalent rare earth ions. Eigenfunctions and eigenvalues of Lea et al. are employed in deducing the ground states and relative Stark splittings of the rare earth ions. The ground states are: $Pr^{3+}(\Gamma_5)$; $Nd^{3+}(\Gamma_5)$; $Pm^{3+}(\Gamma_1)$; $Tb^{3+}(\Gamma_3)$; $Dy^{3+}(\Gamma_5)$; $Ho^{3+}(\Gamma_3)$; $Er^{3+}(\Gamma_7)$; $Tm^{3+}(\Gamma_2)$; $Yb^{3+}(\Gamma_7)$. Optical spectra are discussed. (auth)

4143 ELECTROLYTIC URANIUM PLATING. Karel Šplichal (Inst. for Nuclear Research, Řež, Czechoslovakia). Jaderna Energie, 10: 287-91(Aug. 1964). (In Czech)

Experimental conditions were studied for uranium plating with Ni, Cu, Cr, and Sn, and coatings were obtained, equivalent in quality to classical galvanic coatings. Adhesion and corrosion resistance of nickel and copper coatings were substantially increased by diffusion annealing. Nickel and copper coatings prepared were tested for use as interlayers in diffusion joining of uranium and magnesium cladding. Copper coatings were proved effective antioxidation protection in heat treatment connected with rotary forging of uranium in the temperature range 300 to 600°C and at 60% reduction. (auth)

4144 CATALYSED REACTION OF XENON WITH FLUORINE. B. G. Baker and P. G. Fox (Commonwealth Scientific and Industrial Research Organization, Melbourne and Univ. of Melbourne). Nature, 204: 466-7 (Oct. 31, 1964).

It is found that Ni, and to a lesser extent Cu and Al, have a catalytic effect on the production of xenon fluorides from mixtures of Xe and F. (T.F.H.)

4145 ZEEMAN EFFECT FOR f-d TRANSITIONS IN THE SPECTRA OF Sm^{2+} ACTIVATED ALKALI-EARTH FLUORIDE CRYSTALS. B. P. Zakharchenya, V. P. Makarov, and A. Ya. Ryskin. Opt. Spectry. (USSR) (English Transl.), 17: 116-20(Aug. 1964). Translated from Opt. i Spektroskopiya, 17: 219-29(Aug. 1964).

An investigation was made of the Zeeman effect of the most intense emission lines in MeF_2-Sm^{2+} crystals (Me = Ca, Sr, Ba) and of narrow absorption lines in CaF_2-Sm^{2+} and SrF_2-Sm^{2+}. The experimental data are analyzed on the basis of group theoretical concepts of f-d transitions in a crystal. Two approximations were used in calculating states of the f^5d configuration. In one of them the interac-

tion of f^5 electrons with the crystal field is considered to be stronger than their interaction with a d electron, in the other the interaction of a d electron with an f^5 residue is assumed to be stronger than the interaction of the f^5 electrons with the field. The second indicated approximation is in better agreement with experiment. (auth)

4146 MOLECULAR MOTIONS IN LIQUID AND SOLID ORTHOHYDROGEN. P. A. Egelstaff, B. C. Haywood, F. J. Webb, and A. H. Baston (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 12: 188-9 (Oct. 1, 1964).

The distributions of slow neutrons scattered by solid and liquid $o-H_2$ are measured at 12 to 21°K. The contribution of $p-H_2$ scattering is shown to be about 2%, and is ignored. Attention is focused on: broadening of the quasi-elastic scattering peak by splitting of the triplet ortho state; de-excitation of the ortho–para transition at about 15 Mev by neutron scattering; and the relation between the peak broadening and the diffusive and vibrational models of the molecules. (T.F.H.)

4147 PARAMAGNETIC RESONANCE OF Er^{+++} IN CALCIUM AND STRONTIUM OXIDE. I. C. Chang and W. W. Anderson (Stanford Univ., Calif.). Phys. Letters, 13: 112-13(Nov. 15, 1964).

Electron paramagnetic resonance of Er^{3+} in single crystals of CaO and SrO was observed at 9.3 and 35 Bcps at liquid helium temperatures. Transitions were identified, and the g-values were determined. Transitions associated with the Γ_8 quartet were particularly considered. (D.C.W.)

4148 PARAMAGNETIC RELAXATION IN HOLMIUM ETHYLSULFATE. S. Huefner and G. Weber (Technische Hochschule, Darmstadt, Ger.). Phys. Letters, 13: 115-16 (Nov. 15, 1964).

The magnetic susceptibility of single crystals of holmium ethylsulfate was recorded at different frequencies of an alternating magnetic field between 20 cps and 5.4 kcps as a function of static magnetic field to 2.7 kgauss. Cross relaxation processes were observed in which nuclear hyperfine levels and electron levels participate simultaneously. (D.C.W.)

4149 ISOMER SHIFT ON Eu^{151}. P. Brix, S. Huefner, P. Kienle, and D. Quitmann (Institut fur Technische Kernphysik, Darmstadt, Ger. and Technische Hochschule, Darmstadt, Ger.). Phys. Letters, 13: 140-2(Nov. 15, 1964).

The isomer shifts of divalent and trivalent Eu compounds and metallic Eu for the 21.7-kev gamma line of ^{151}Eu were obtained. The results are presented, and a procedure for analyzing the isomer shifts of the rare earths is proposed. (D.C.W.)

4150 DYNAMICS OF ENERGY TRANSFER FROM 3d TO 4f ELECTRONS IN $LaAlO_3:Cr^{3+}Nd^{3+}$. Zoltan J. Kiss (RCA Labs., Princeton, N. J.). Phys. Rev. Letters, 13: 654-6(Nov. 30, 1964).

The dynamics of the energy-transfer mechanism from Cr^{3+} to Nd^{3+} was investigated in single crystals of $LaAlO_3$. The energy transfer rates are described for the $LaAlO_3:Cr^{3+}Nd^{3+}$ system, and evidence is presented that the energy transfer takes place entirely from the ^2E metastable level of Cr^{3+} to the Nd^{3+} system. It is suggested that the transfer rate is of the order of 10^{-9} second. (C.E.S.)

4151 IONIZED F-AGGREGATE COLOR CENTERS IN KCl. I. Schneider and Herbert Rabin (Naval Research Lab., Washington, D. C.). Phys. Rev. Letters, 13: 690-2(Dec. 7, 1964).

Evidence is reported for the existence of ionized F-aggregate color centers in KCl, specifically the F_2^+ and F_3^+ centers, which are ionized M and R centers, respectively. A new absorption band occurring at 1.4μ is believed to be due to a transition of the F_2^+ center, and it appears very likely that a band at about 960 mμ arises from a transition of the F_3^+ center. (C.E.S.)

4152 STRUCTURE OF THE SPECTRA OF DISORDERED SYSTEMS. II. SPECTRA GAPS OF DISORDERED SYSTEMS. Jun-ichi Hori (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 32: 371-9(Sept. 1964).

It is shown that for the vibrational frequency spectrum of isotopically or nonisotopically disordered polyatomic chain and for the electronic energy spectrum of the disordered Kronig-Penney model with randomly varying strength of potentials and interval between them, the second theorem presented in the first paper reduces to a theorem which is very similar to the ordinary Saxon-Hutner's theorem. For the case in which only the interval between potentials is disordered, the theorem leads to the condition for persistence of spectral gaps, which is just what was previously found by Borland. The validity of the ordinary Saxon-Hutner's theorem is also discussed. (auth)

4153 STRUCTURAL ASPECTS OF ZIRCONIUM CHEMISTRY. Abraham Clearfield (National Lead Co., Niagara Falls, N. Y.). Rev. Pure Appl. Chem., 14: 91-108(Sept. 1964)

Structural data on zirconium are summarized and evaluated. Structural principles of zirconium chemistry were developed based on experimental fact. Zirconium tetrahalides, hexahalozirconates, and complexes of tetrahalides with organic ligands are discussed. Coordination and bonding characteristics of oxygen-containing zirconium compounds are described. The aqueous chemistry of zirconium, hydrolytic polymerization and the hydrous oxides, zirconium sulfates, and zirconium chelates are discussed. (94 references) (M.C.G.)

4154 ON THE ELECTRONIC SPIN RESONANCE OF THE PLATINUM–CARBON SYSTEM AND ITS CATALYTIC ACTIVITY. Ioan Ursu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 263-8(1964).

The C-Pt system used as a catalyst in the H-D isotopic exchange reaction was studied by the ESR method. The spin/g concentration of the C-Pt system was determined for different concentrations of Pt as a function of temperature in vacuum and in gases (air, oxygen, hydrogen, nitrogen, and ethylene). A marked reduction of the spin/g concentration was generally observed in the oxygen atmosphere. The catalytic activity of the C-Pt system was measured for the H-D exchange reaction in oxygen. A marked decrease of the catalytic activity was observed in the exchange reaction as a function of oxygen concentration. Under these conditions a parallel is noted between the decrease of the active centers of the C-Pt system for the isotopic exchange reaction and the decrease of the spin/g concentration in oxygen. (D.C.W.)

4155 HIGH-PRESSURE B-TYPE POLYMORPHS OF SOME RARE-EARTH SESQUIOXIDES. Henry R. Hoekstra and Karl A. Gingerich (Argonne National Lab., Ill.). Science, 146: 1163-4(Nov. 27, 1964).

High pressure forms of the sesquioxides of holmium, erbium, thulium, ytterbium, lutetium, and yttrium were obtained by exposure of the C-type sesquioxides to pressures between 25 and 40 kilobars and temperatures between 900 and 1020°C. X-ray diffraction analysis showed that these high-pressure phases are of the monoclinic B-type, which is known for several of the lighter rare earth sesquioxides (samarium through dysprosium). (auth)

4156 TEMPERATURE DEPENDENCE OF THE NUCLEAR QUADRUPOLE RESONANCE FREQUENCY OF ^{35}Cl AND $^{63}Cu^+$ IN CERTAIN COMPOUNDS. D. F. Baisa and A. F. Prikhot'ko (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 9: 573-5(May 1964). (In Ukrainian)

The nuclear quadrupole frequency of ^{35}Cl in polycrystalline p-dichlorobenzene, chlorobenzene, dichloroethane and of $^{63}Cu^+$ in cuprous oxide was measured at various temperatures. A scintillation quadrupole spectrometer with a frequency range from 15 to 40 Mc was used for the measurements. It was found that the rotational oscillation frequencies at 300 to 93°K differ from the frequency determined on the basis of the spectrum scattering. The data indicate that the formulas derived by Bayer can be used for calibration at liquid He temperature. At that temperature, the rotational oscillation frequency of molecular and ionic crystals were found to be identical, although this was not expected. (TTT)

4157 THE THERMAL BROADENING OF THE MÖSSBAUER LINE. Tan Lu. Wu Li Hsueh Pao, 20: 777-84 (Aug. 1964). (In Chinese)

The broadening of the Mössbauer line due to the fluctuation of lattice vibration (named thermal broadening) is discussed. The quantitative formula relating this broadening to the structure of localized vibrational modes (with discrete frequencies) round the impurity radiating atom in crystal is obtained, and the thermal broadening in the degenerate case is analyzed in detail. (auth)

4158 ISOTOPIC EFFECT IN THE MAGNITUDE OF THE MOLAR VOLUMES OF IONIC CRYSTALS. V. S. Kogan and T. G. Omarov. Zh. Eksperim. i Teor. Fiz., 47: 789-94(Sept. 1964). (In Russian)

The lattice constants of ^{24}MgO and ^{26}MgO, ^{40}CaO and ^{48}CaO, ^{58}NiO and ^{64}NiO are determined at room and nitrogen temperatures. It is shown that at 78°K in all investigated compounds the isotopic effect in the molar volumes is positive ($V_a > V_T$). The thermal expansion coefficient is higher in compounds with the heavy isotope. Therefore the isotopic effect in crystal lattice size which is maximal at low temperatures decreases with increase of temperature. In MgO and NiO it is almost zero at room temperature and changes sign between 78 and 300°K in CaO. Inversion of the isotopic effect cannot be explained by the Debye theory of solid bodies. A correlation between the nature of the binding forces in the lattice and characteristics of the isotopic effect can be derived by comparing the results of investigation of the isotopic effect in the lattice constants of ionic crystals with results previously obtained in molecular and metallic crystals. (auth)

4159 REDKOZEMELNYE ELEMENTY. (Rare-Earth Elements). D. I. Ryabchikov, ed. Moscow, Izdatel'stvo Akademii Nauk SSSR, 1963. 392p.

Sixty-three articles are included on physico-chemical studies of rare earths. Analytical and separation methods are discussed and preparation and properties of rare earth compounds are described. (R.V.J.)

4160 ISSLEDOVANIYA V OBLASTI KHIMII URANA. (Investigation of Uranium Chemistry). Vikt. I. Spitsyn. [Moscow], Izdatel'stvo Moskovskogo Universiteta, 1961. 304p.

Forty-five articles are included on physico-chemical properties of uranium compounds. Thermographic, potentiometric, conductometric, and x-ray analyses were made of the solubility, thermal stability, heat of formation, and crystal structure of phosphates, sulfides, oxysulfides, silicates, and double vanadates. (R.V.J.)

4161 NOUVEAU TRAITÉ DE CHIMIE MINÉRALE. TOME XV. URANIUM ET TRANSURANIENS. TROISIEME FASCICULE. TRANSURANIENS. (New Treatise on Inorganic Chemistry. Volume XV. Uranium and Transuranic Elements. Part 3. Transuranic Elements). Paul Pascal, ed. Paris, Masson et Cie, 1962. 1131p.

After a brief introduction to the chemistry of the radioactive elements, the naturally radioactive and transuranium elements are discussed. The separation, purification, preparation, compounds, systems, and properties of Np, Pu, Am, and Cm are then surveyed, together with the oxidation-reduction processes of Np and Pu and the alloys, metallurgy, and complexes of Pu. Be, Cf, Es, Fm, Md, and No are briefly treated. Measurement of radioactivity in the atmosphere is also considered. (D.C.W.)

4162 NOUVEAU TRAITÉ DE CHIMIE MINÉRALE. TOME IX. TITANE, ZIRCONIUM, HAFNIUM, THORIUM. (New Treatise on Inorganic Chemistry. Volume IX. Titanium, Zirconium, Hafnium, Thorium). Paul Pascal, ed. Paris, Masson et Cie, 1963. 1250p.

A survey on the preparation, physical properties, and chemical properties of Hf, Th, Ti, and Zr, and compounds, derivatives, and systems thereof is presented. (D.C.W.)

4163 NOUVEAU TRAITÉ DE CHIMIE MINÉRALE. TOME XV. URANIUM ET TRANSURANIENS. DEUXIEME FASCICULE. COMBINAISONS DE L'URANIUM. (New Treatise on Inorganic Chemistry. Volume XV. Uranium and Transuranic Elements. Part 2. Uranium Compounds). Paul Pascal, ed. Paris, Masson et Cie, 1961. 690p.

A survey is presented on the preparation, physical properties, and chemical properties of uranium compounds and systems and of uranyl salts. The technology of UO_2 for use as reactor fuel; fission products of uranium; treatment of irradiated uranium; and the dangers presented by uranium, thorium, and the transuranium elements are also covered. (D.C.W.)

4164 FLUID BED DENITRATION VESSEL (Engineering Materials). (Mallinckrodt Chemical Works, St. Louis). (CAPE-1172)

This package contains 5 drawings. For a listing of individual titles see the Engineering Materials List (TID-4100). This fluidized bed denitration vessel is used to convert molten uranyl nitrate salt to uranium trioxide of controlled particle size range. The recovery of nitric acid values is accomplished in conventional absorption equipment. Vessel details include the instrument control board, off-gas filter, tube bundle, and tube sheet used for heat transfer and gas distribution. (F.S.)

4165 VACUUM DISTILLATION SYSTEM (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1130)

This package contains 20 drawings. For a listing of individual titles see the Engineering Materials List (TID-4100). This system is used in concentrating dilute aqueous solutions of thermally labile solutes at temperatures of 15 to 25°C. Concentration ratios of 2 to more than 100 can be obtained depending on solubility and original volume. Air is removed from the system for operation at the vapor pressure of the water condensate (5.3 mm Hg). Four boilers permit simultaneous concentration of four separate solutions at a water removal rate of ~770 ml/hr per boiler. Over 99% solute is recovered for a 30:1 concentration of a 0.00002N oxalic acid solution. A mechanical refrigeration system is used to condense the distillation at 2°C. (F.S.)

4166 ISOTOPE EXCHANGE RATES. I. THE HOMOGENEOUS REACTION BETWEEN DEUTERIUM AND AMMONIA. Assa Lifshitz, Chava Lifshitz, and S. H. Bauer (Cornell Univ., Ithaca, N. Y.). 20p. (CONF-179-16)

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

The thermal isotope exchange reaction between deuterium and ammonia (highly diluted with argon) was investigated behind reflected shocks in a single-pulse shock tube. The temperature range covered was 1300–1700°K. The reaction orders with respect to ammonia and deuterium, as well as the total reaction order were determined. The exchange rate was found to be approximately unit order with respect to deuterium and argon, and zero order with respect to ammonia. From the known rates of dissociation of D_2 it is evident that the reaction does not proceed via a three center atomic displacement intermediate. A mechanism based on the vibrational excitation of deuterium molecules by argon as the rate determining step is proposed. (auth)

4167 HIGH TEMPERATURE EQUATION OF STATE OF URANIUM DIOXIDE. R. A. Meyer and B. Wolfe (General Electric Co., San Jose, Calif.). 6p. (CONF-446-57)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

An estimate of the high-temperature equation of state of UO_2 is presented for conditions corresponding to an extreme accident in a nuclear reactor. The calculation assumes that the UO_2 molecule remains intact, i.e., ionization and dissociation effects are not considered. (P.C.H.)

4168 PROCESS FOR THE DIRECT PREPARATION OF PRACTICALLY SPHERICAL GRANULAR, URANIUM-CONTAINING MATERIAL OF A DEFINITE PARTICLE SIZE. (to Stichting Reactor Centrum Nederland). British Patent 968,679. Sept. 2, 1964. Priority date Sept. 18, 1959, Netherlands.

A process is given for preparing uraniferous particles of uniform size, spherical shape, and smooth surface, for use in reactor fuel slurries. The process is based on the discovery that such particles can be precipitated from a solution of uranyl salt (preferably uranyl nitrate) by the sequen-

tial addition of ammonia and ammonium sulfate. The factors involved in the process are discussed, particularly the critical pH value. The process is useful for the preparation of granular UO_2, and two examples of such use are given. (D.L.C.)

4169 METHOD FOR THE PREPARATION OF METAL OXIDE SOLS WITH TWO OXIDE CONSTITUENTS. (to W. R. Grace and Co.). British Patent 968,701. Sept. 2, 1964. Priority date July 7, 1960, United States.

A process is given for preparing stable sols of ThO_2-UO_2 or ThO_2-UO_3 for use as fuel in homogeneous reactors. These sols are characterized in that one oxide coats the other, and their preparation is based on the fact that U^{4+}, Th^{4+}, and U^{6+} hydrolyze at different pHs. The process for the preparation of UO_2 coated with ThO_2 comprises heating and agitating a solution of Th^{4+} and U^{4+} salts in the presence of urea, interrupting the hydrolysis and cooling the solution when the hydrolysis of U^{4+} is complete, resuming the heating until the pH is 3.0 to 5.0, and treating the resultant sol to remove electrolytes. The process is similar for the preparation of ThO_2 coated with UO_3. Several examples of the process are given. The hydrothermal stability may be further improved by coating with silica. (D.L.C.)

4170 METHOD FOR THE PREPARATION OF HIGH-PURITY BORON. Heinz Wirth and Wolfgang Dietz (to Consortium fur Elektrochemische Industrie GmbH). German Patent 1,174,750. July 30, 1964. Filed Aug. 14, 1962.

Boron of high purity is produced by the thermal disintegration of gaseous hydroboron at about 500 to 600°C by contacting it with tantalum wires. The method comprises the steps of increasing the throughput of hydroboron during the deposition and of stopping the deposition before tantalum boride formation starts. (Gmelin Inst.)

4171 METHOD FOR THE PREPARATION OF URANIUM(IV) OXIDE SOL USABLE IN NUCLEAR REACTORS. Frederick Troop Fitsch (to W. R. Grace & Co.). German Patent 1,175,658. Aug. 13, 1964. Priority date, Feb. 28, 1962, [United States].

Sols of uranium(IV) oxide particles dispersed in a watery medium are produced by treating a solution of uranium(IV) oxide salt at a temperature of about 100 to 200°C for about 2 to 40 hours in an autoclave. The liquid phase is separated from the solid product obtained, and the solid product dispersed in a known manner with desalinated water to obtain the sol. (Gmelin Inst.)

4172 DOUBLE OXIDE OF URANIUM AND COPPER. James S. Gill and William L. Marshall. U. S. Patent 3,157,461. Nov. 17, 1964. Filed July 27, 1960.

A method of preparing $CuO \cdot 3UO_3$, useful as a catalyst is given. A mixture of $UO_3 \cdot H_2O$, CuO, and H_2SO_4 in H_2O was equilibrated at 300°C under pressure, then quenched in ice water. The solid produced was composed of antlerite and red $CuO \cdot 3UO_3$. (T.R.H.)

Organic Chemistry

4173 (BNL-8621) COMPETITIVE GAS PHASE REACTIONS OF ^{11}C IN BINARY OXYGEN–ALKANE SYSTEMS. G. Stoecklin and A. P. Wolf (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract [AT(30-2)-Gen-16]. 20p. (CONF-773-4). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Carbon-11 produced by $^{12}C(n,2n)$ and $^{12}C(p,pn)$ reactions were used to study the reactions of recoil carbon with alkanes in the presence of O_2. Yields of CO, C_2H_2, and C_2H_4 were determined for methane, ethane, propane, and other alkanes. The C_2H_2 yield was found to be proportional to the relative number of primary C atoms in the alkane, while the C_2H_4 yields depend directly on the number of primary H atoms. The CO yield is inversely proportional to the total number of hydrogen atoms in the alkane. The results are interpreted as confirming the insertion reaction mechanism. (D.L.C.)

4174 (EUR-1828.d) UNTERSUCHUNGEN UBER DIE LAGERFAHIGKEIT H-3-MARKIERTER AMINOSAUREN HOHER SPEZIFISCHER AKTIVITAT. (Study of the Stability of Tritium-Labeled Amino Acids of High Specific Activity). W. Nouvertne and K. Hempel (Cologne. Universität. Institut für Medizinische Isotopenforschung). 1964. 18p. Dep.(mn).

Phenylalanine-$(2,4-T_2)$, lysine $(\gamma,\delta-T_2)$, and 3,4-dihydroxyphenylalanine-$(2,5,6-T_3)$ of high specific activity (8000 mC/m Mol and more) were stored in solute (solvent: 80% ethanol or water) and in solid form under ten different conditions. The radiochemical purity of the amino acids was investigated by paper chromatography after varying storage time. Maximum stability was shown by tritiated amino acids in ethanol solution at low temperature. Under these conditions, tritiated phenylalanine and lysine could be stored up to six months without developing more than one percent tritiated impurities. (auth)

4175 (IS-855) PROPAGATION CHARACTERISTICS OF CAPILLARY RIPPLES ON SOLUTIONS OF LOW MOLECULAR-WEIGHT ORGANIC ACIDS. Stuart C. Grossman and R. S. Hansen (Ames Lab., Ames, Iowa). July 1964. Contract W-7405-eng-82. 82p. Dep.; $3.00(cy), 1(mn) OTS.

The viscoelastic theory for ripples at a liquid–air interface has been sketched. It includes corrections for any gravity effects. The electronic instrumentation has been modified to include frequencies below 200 cps. The weight of the ripple generator is an important factor to consider as it should be heavier for the lower frequencies and lighter for the higher ones. Water and solutions of low molecular-weight organic acids were studied. These acids were propionic, n-butyric, isobutyric, n-valeric, isovaleric, n-caproic, and n-heptanoic. Water follows a non-viscoelastic theory at the three temperatures studied. The acids required only one adjustable parameter in the theory presented by Hansen and Mann. The acids up to four carbon atoms form slightly viscoelastic solutions. n-Valeric, isovaleric, n-caproic acid, and n-heptanoic acid solutions are described by the theory for intermediate viscoelastic films. (auth)

4176 (AEC-tr-6227/2(p.131-7)) A METHOD FOR THE BIOSYNTHETIC LABELING AND THE ISOLATION OF PYRIMIDINE NUCLEOTIDES. S. Petrovic and J. Petrovic. Translated from Bull. Boris Kidrich Inst. Nucl. Sci., 15: No. 2, 131-7(1964).

Pyrimidine nucleotides labeled with ^{14}C exclusively in position 6 of the pyrimidine nucleus can be obtained with reasonably high specific activities from the acid-soluble fraction of rat liver, 1.5–2.5 hr following injection of an adequate amount of orotic acid-$(6-^{14}C)$. Utilization of the precursor is 40–50 percent. The data presented show the kinetics of the radioactive pyrimidines in the acid-soluble fraction of rat liver between 1 and 5 hr after administration of orotic acid. Methods are described for the quantitative hydrolysis of the pyrimidine nucleotides to monophosphates, quantitative absorption on and desorption from activated charcoal, and quantitative resolution which gives 96–100 percent pure products. (auth)

4177 (ANL-Trans-112) THE pH-FUNCTION OF THE FLUORESCENCE OF NAPHTHALINE DERIVATIVES. Th. Foerster. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Z. Elektrochem., 54: 531-5(Dec. 1950). 9p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

The independence of the shiftings of the fluorescence and absorption spectra at the passage of the pH-scale in aqueous solution can be observed at the excitation by light of a sufficiently short wavelength also in the case of naphthols, naphthylamines, and their sulfonic acids. These phenomena can be explained by a more or less complete adjustment of the electrolytic dissociation equilibria during the duration of the excitation. The interpretation of the fluorescence shiftings observed for the sulfonic acids of aromatic amines in alkaline solution by the dissociation of the amino groups has been confirmed by studies on dimethylaminosulfonic acids. (auth)

4178 A NEW MODIFICATION OF DEUTERATED OXALIC ACID DIHYDRATE $(COOD)_2 \cdot 2D_2O$. Fujiko Fukushima, Hitoshi Iwasaki, and Yoshihiko Saito (Tokyo Univ.). Acta Cryst., 17: 1472(Nov. 10, 1964).

The crystal structure of deuterated oxalic acid dihydrate, $(COOD)_2 \cdot 2D_2O$, was studied and compared with the crystal structure of α-oxalic acid dihydrate. The atomic coordinates give the reliability index $R = \Sigma \, ||F_o| - |F_c|| / \Sigma \, |F_o|$ of 0.13 for h0l and hk0 reflections. The oxalic acid molecules lie nearly in one plane which makes an angle of about 53° with the plane (010), whereas the corresponding angle of the α form is 29°. The hydrogen bond lengths are 2.58, 2.89, and 2.82 Å, while in α-oxalic acid dihydrate they are 2.49, 2.89, and 2.88 Å, respectively. This shows that the directions of the maximum isotope effects lie near to the directions of short hydrogen bonds. (P.C.H.)

4179 PYROLYSIS OF BIPHENYL IN VAPOR PHASE AND LIQUID PHASE. Michel Lutz. Compt. Rend., 259: 1841-4(Sept. 14, 1964). (In French)

Biphenyl is pyrolyzed in Pyrex glass ampules under vacuum at a temperature of 400°C in such a manner that the decomposition rate does not exceed 1%. The formation of different products is described as a function of the liquid-vapor distribution of biphenyl in the ampule. The effect of the surface on the yields of pyrolysis products was taken into consideration. (tr-auth)

4180 THE REACTIONS OF ATOMIC CARBON WITH ETHYLENE. I. PRODUCTION OF ALLENE AND METHYLACETYLENE. Maryan Marshall, Colin MacKay, and Richard Wolfgang (Yale Univ., New Haven and Haverford Coll., Penna.). J. Am. Chem. Soc., 86: 4741-7(Nov. 20, 1964). (NYO-1957-48)

Insertion reactions of ^{11}C atoms into ethylene were further investigated by detailed studies on two important products: ^{11}C-allene and ^{11}C-methylacetylene. The ^{11}C atoms were produced as hot atoms by nuclear techniques. Degradative studies showed that most of the allene is center labeled ($CH_2 = {}^{11}C = CH_2$) under all conditions. End labeling was more important in methylacetylene than it was in allene. These data, results of double tracer experiments and observations on phase, temperature, and moderator dependences, indicated that most of the allene and a significant fraction of the methylacetylene are formed by carbon atom insertion into the ethylene π-bond. Insertion into the C–H bond, giving end-labeled allene and methylacetylene, was of lesser importance. The principal species involved in the predominant center-labeling mode seemed to be the $C(^1D)$ rather than the ground state $C(^3P)$ atom. Moderators were used to distinguish between reactions at thermal and high kinetic energies. It was found that both hot and thermal carbon atoms reacted by similar modes, but that the thermal species showed more discrimination, favoring π-bond over C–H bond attack. No temperature effect was found in the moderated system, in keeping with the expectation that both types of insertion reactions have very low activation energies. (auth)

4181 REACTIONS OF CARBON ATOMS WITH ETHYLENE. II. PRODUCTION OF ACETYLENE AND C_5 COMPOUNDS. James Dubrin, Colin MacKay, and Richard Wolfgang (Yale Univ., New Haven and Haverford Coll., Penna.). J. Am. Chem. Soc., 86: 4747-52(Nov. 20, 1964). (NYO-1957-49)

Reaction mechanisms of atomic carbon (produced as ^{11}C by nuclear transformations) with ethylene were studied. Sixteen products were identified, most of them minor. These account for the bulk of the reacting carbon atoms. (Unidentified products appeared to be largely polymeric.) Variations of this product spectrum were studied upon change of phase, addition of scavenger, and thermalization of the carbon atoms by neon moderator. These variations suggested that the products fall into two groups of different origin: C_3 compounds, allene and methylacetylene; and acetylene and various unsaturated C_5 compounds (plus small yields of C_4 molecules). The C_3 compounds are believed to be largely formed by insertion of $C(^1D)$ into the C=C and C–H bonds with stabilization of the resulting adducts. However, insertion of $C(^3P)$ into C–H and C=C bonds leads to adducts that are not readily stabilized because of their triplet character. These adducts have sufficient excitation energy to decompose to acetylene, other C_2, or C_3 species. If decomposition to a stable molecule does not occur prior to collisional energy deactivation, the residual C_3 radicals will add ethylene to eventually yield certain specific C_5 products. These competitive modes of reaction of the C_3 adducts are discussed. It was found that the simple reaction model proposed can fully account for the complex product patterns found. (auth)

4182 KINETICS OF THE OXIDATION OF ALLYL ALCOHOLS WITH DICHLORODICYANOQUINONE. CONFORMATIONAL AND ISOTOPE EFFECTS. Sumner H. Burstein and Howard J. Ringold (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). J. Am. Chem. Soc., 86: 4952-58(Nov. 20, 1964).

Kinetic and thermodynamic parameters of the oxidation of a number of steroidal Δ^4-3-hydroxy steroids with dichlorodicyanoquinone (DDQ) were studied. The reaction, which exhibited a first-order dependence on steroid and on quinone, was formulated as proceeding via a slow hydride transfer followed by a rapid proton loss. The primary deuterium isotope effects were large (ca. fivefold) as were the negative entropies of activation. The slower reaction rates in dioxane, as compared to those in t-butyl alcohol, appeared to be caused by a relatively greater orientation of solvent in a charged transition state. Equatorial alcohols were found to be oxidized faster than the axial isomers, a fact which is attributed to favorable σ-π overlap of the departing axial hydride in the case of the former. This effect, however, appeared in the ΔS^* term for which an explanation is advanced. (auth)

4183 PRIMARY AND SECONDARY SOLVENT ISOTOPE EFFECTS. M. M. Kreevoy, P. J. Steinwand, and W. V. Kayser (Univ. of Minnesota, Minneapolis). J. Am. Chem. Soc., 86: 5013-14(Nov. 20, 1964).

The quantitative separation and evaluation of primary and secondary solvent isotope effects on the acid cleavage of allylmercuric iodide are described. The rate was accurately first order in substrate to >95% of completion. The infinite dilution value of the rate constant, k_H, was $4.0 \pm 0.1 \times 10^{-2}$ l mole^{-1} sec^{-1} at 35°C. A value of $1.23 \pm 0.06 \times 10^{-2}$ l mole^{-1} sec^{-1} was obtained for k_D with D_2O as solvent instead of perchloric acid. This led to a value of 3.25 for k_H/k_D. These results showed that the rate-determining step is proton transfer to the γ-carbon of the allyl group. The k_H/k_D ratio measures two kinds of isotope effects: that produced by changing the proton being transferred to carbon to a deuteron and that produced by changing the remaining protons to deuterons. These effects were separated by using partially deuterated solvent and results presented in tabular form. (M.C.G.)

4184 THE MECHANISM OF RECOIL TRITIUM REACTIONS. FORMATION OF LABELED ALKENES FROM SATURATED HYDROCARBONS AND HALOCARBONS. Edward K. C. Lee, Y. N. Tang, and F. S. Rowland (Univ. of Kansas, Lawrence). J. Am. Chem. Soc., 86: 5038-9 (Nov. 20, 1964).

Substitution of recoil tritium atoms onto the carbon skeleton of many saturated hydrocarbons or halocarbons was found to produce significant yields of various labeled olefins. A possible mechanism for this is suggested to be the replacement of a single group in the primary energetic process, followed by the unimolecular elimination of a small molecule from the excited labeled product. (M.C.G.)

4185 ANTIRADIATION COMPOUNDS. V. α-AMINO ACID ESTERS OF 2-MERCAPTOETHYLAMINE. William O. Foye and Robert H. Zaim (Massachusetts Coll. of Pharmacy, Boston). J. Pharm. Sci., 53: 906-8(Aug. 1964).

β-Mercaptoethylamine (MEA) is a very effective radiation-protective compound, but shows toxic symptoms with doses close to those necessary for radioprotection. To provide less toxic and longer-acting derivatives of MEA, thioesters with α-amino acids were prepared. These esters of MEA should liberate MEA in vivo over a period of time, or possibly function as more active thiolation agents in vivo than the mercaptan. The method of preparation of

the α-amino acid thioesters consisted of a dry fusion of the α-amino acid chloride hydrochloride and MEA hydrochloride. An excess of MEA hydrochloride was effective in obtaining products of good purity. Physical properties of the eight thioesters prepared are tabulated. Hydrolysis rate constants were determined for the thioesters in acetate buffer at pH 3.7 and a temperature of 15°. The following sequence of hydrolytic reaction rates, in decreasing order, was found: L-prolyl > glycyl > DL-methionyl > DL-β-phenylalanyl > DL-alanyl > L-leucyl > DL-α-aminobutyryl > DL-valyl. It is apparent that neither molecular weight nor chain length are determinant factors in the ease of hydrolysis of these esters. A paper chromatographic determination of the hydrolysis products was made of the valyl derivative. Thus, S-valyl MEA liberated MEA, the disulfide of MEA, and N-valyl MEA. It is considered unlikely that the S → N acyl shift occurred at the low pH (3.7) of the hydrolysis rate determinations, but it appears probable that some N-acyl derivative would be formed in vivo or in the solutions (pH 7.4) used for antiradiation testing. Antiradiation testing results are not yet available for these compounds. (BBB)

4186 CATALYTIC DEUTERIUM EXCHANGE REACTIONS WITH ORGANICS. XIV. DISTINCTION BETWEEN ASSOCIATIVE AND DISSOCIATIVE π-COMPLEX SUBSTITUTION MECHANISMS. J. L. Garnett and W. A. Sollich-Baumgartner (Univ. of New South Wales, Sydney). J. Phys. Chem., 68: 3177-83(Nov. 1964).

The relative importance of the associative and dissociative π-complex substitution mechanisms in group VIII transition metal catalyzed exchange reactions between heavy water and aromatic molecules was investigated by comparing the rate of D_2O-benzene exchange reactions to the randomization rate of a mixture of normal and 98.3% deuterated benzene. Kinetic equations were derived for the randomization process on the assumption that random deuterium incorporation occurs at all stages of the reaction. A test of these equations showed that this assumption was not valid. A semiempirical method was therefore developed for the calculation of randomization rate constants. The results show that randomization occurs at a rate which is 70% as fast as deuterium oxide exchange. This difference in the two reaction rates is readily explained by water activation of the catalyst. It was concluded that the dissociative π-complex substitution mechanism is the predominant process by which deuterium oxide exchanges catalytically with aromatic molecules. Isotope effect studies show that the reaction between chemisorbed benzene and chemisorbed hydrogen is the rate-determining process of the exchange reaction. (auth)

4187 SYNTHESIS AND METABOLISM OF HALOTHANE-1-^{14}C. Russell A. Van Dyke, Maynard B. Chenoweth, and Eric R. Larsen (Dow Chemical Co., Midland, Mich.). Nature, 204: 471-2(Oct. 31, 1964).

The synthesis of $^{14}CF_3CBrClH$ is described, starting from chloroacetic-1-^{14}C acid. The labeled C atom is metabolized only slightly within 24 hr of intraperitoneal injection; only 0.84% of the ^{14}C appears as CO_2 within this period. (T.F.H.)

4188 METASTABLE MOLECULE IONS WITH LIFETIMES IN THE 100 μSEC REGION. U. Von Zahn and H. Tatarczyk (Universität, Bonn.). Phys. Letters, 12: 190-1 (Oct. 1, 1964).

Polyatomic molecules are ionized by electron impact. The ions then pass through a double-focusing mass spectrometer, a drift tube with a quadrupole r-f field and no d-c field, and a second mass spectrometer. The apparatus is used to study the transitions of these ions with decay rates on the order of 10^4/sec. It is concluded that an appreciable number of parent and daughter ions in metastable states have lifetimes greater than 10 μsec, in agreement with statistical theory. For n-hexane, n-pentane, and n-butane, at least, it is found that the most abundant transitions have lifetimes on the order of 1 msec. (T.F.H.)

4189 ISOTOPE EXCHANGE RATES. II. MECHANISM OF THE HOMOGENEOUS REACTION BETWEEN ACETYLENE AND DEUTERIUM. Kenji Kuratani and S. H. Bauer (Cornell Univ., Ithaca, N. Y.). 34p. (CONF-179-15)

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

The homogeneous gas-phase reaction between acetylene and deuterium was investigated in a shock tube over the temperature range 1300 to 1665°K. Incident shocks in samples highly diluted with argon (80–87%) were used; compression factors by the shock were in the interval 3.6 to 4.3, for initial total pressures (at 300°K) of 23–110 mm Hg. The rate of substitution of D for H was followed by recording the emission intensity in the infrared, due to C_2HD (at 2555 cm^{-1}), and to C_2H_2 (at 3195 cm^{-1}). The total order for the substitution reaction was 1.24 ± 0.05. It was demonstrated that, $d(C_2HD)/dt = -\frac{2}{5}\,[d(C_2H_2)/dt] = k(D_2)^{1.0} \times (C_2H_2)^{0.24}(Ar)^0 \cong 2\,[d(C_2D_2)/dt]$. A mechanism consistent with all the data involves two transient species; the complex $C_2H_2 \cdot D_2$, which is readily destroyed by collisions with C_2H_2 molecules, and $C_2H_2D_2^*$, which resembles a highly excited ethylene. The effective activation energy for the substitution reaction is 32.5 kcal/mole. (auth)

4190 IMPROVEMENTS IN OR RELATING TO TERTIARY AMINE PREPARATION. Gustave Roy, Louis Colson, and Maurice Decuypere (to Commissariat à l'Energie Atomique). British Patent 969,343. Sept. 9, 1964. Priority date Aug. 10, 1960, France.

A process is given for the preparation of pure trialkylamines in which the three alkyl groups are identical and include at least 6 (preferably 8 to 18) carbon atoms. The process comprises reacting gaseous NH_3 with an alkyl bromide, the bromide being at a temperature from 100 to 200°C. A catalyst, Cu_2I_2, is preferably employed. Two examples of the process are given in which trilaurylamine and triacetylamine were prepared. (D.L.C.)

4191 TRITIATED-2-METHYL-NAPHTHAQUINOL-(1,4)-DIPHOSPHORIC ACIDS. Denis Haigh Marrian and Eustace Anthony Evans (to United Kingdom Atomic Energy Authority). U. S. Patent 3,157,684. Nov. 17, 1964. Priority date Feb. 13, 1961, Great Britain.

A stable tritiated 2-methylnaphthaquinol-(1,4) diphosphoric acid salt is prepared for therapy of tumors. In one example, 2-methylnaphthalene-6-sulfonyl chloride was prepared and reduced to the sulfinate which was converted to 2-methyl-6-iodonaphthalene. This was converted to 2-methyl-6-iodonaphthaquinone (1,4) and then to the final product which was tritiated at position 5, 6, 7, or 8. (T.R.H.)

Radiation Chemistry

Refer also to abstracts 4521 and 4553.

4192 (HW-31929(Rev.)) PROMOTION OF CHEMICAL REACTION IN GAS–GRAPHITE SYSTEMS BY GAMMA RADIATION. R. E. Woodley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 24, 1954. Contract AT(45-1)-1350. 26p. Dep.(mn); $2.00(cy), 2(mn) OTS.

Gas-graphite systems have been exposed to the intense gamma radiation of the MTR canal gamma facility to obtain information on the effect of gamma radiation on the chemical reactions between various pure gas atmospheres and graphite. The systems exposed were graphite plus carbon dioxide, graphite plus 85 per cent CO_2–15 per cent He, graphite plus oxygen, and carbon monoxide in the absence of graphite. Results have shown that the extent of reaction which occurs between pure CO_2 and graphite in a static system is very small. The system reached an equilibrium state in a period which is short compared to the total exposure period. The extent of reaction between graphite and a mixture of 85 per cent CO_2 and 15 per cent He in a static system is even less than that between pure CO_2 and graphite. An equilibrium state is also indicated in this case. Graphite undergoes an extensive reaction with pure oxygen with the formation of carbon dioxide. An effective ion pair yield of approximately unity was calculated for this system. Data suggest that equilibrium conditions were not attained in 105 days. Pure carbon

monoxide decomposes under gamma irradiation to form carbon dioxide and a reddish-brown solid polymer of one of the carbon suboxides with the empirical formula C_4O_3. The attainment of equilibrium is implied by experimental results. (auth)

4193 (IDO-17024) THE ELECTRON RADIOLYSIS OF BENZENE–BIPHENYL MIXTURE. A. J. Moffat (Phillips Petroleum Co. Research and Development Dept., Bartlesville, Okla.). Aug. 1964. Contract AT(10-1)-1080. 14p. Dep.; $1.00(cy), 1(mn) OTS.

Mixtures of benzene (also perdeuterobenzene) and biphenyl were irradiated with 6 Mev electrons. The primary polyphenyl products were biphenyl; o-, m-, and p-terphenyls; o,o-, m,m-, p,p-, o,m-, o,p-, and m,p-quaterphenyls. A mechanism is proposed which accounts for the initial distributions of these individual products. The basic radiolytic reaction is divided into two general parts (radical production and radical scavenging). A mathematical treatment is used to derive radical and scavenging probabilities. A close parallel was noted between free radical chemistry and these electron radiolytic studies. (auth)

4194 (NAA-SR-9733) RADIOLYSIS PRODUCTS OF POLYPHENYL COOLANTS. PART II. LOW AND INTERMEDIATE BOILERS. R. A. Baxter, R. C. Shepard, W. L. Orr, L. J. Miller, R. T. Keen, and M. A. Rotheram (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 33p. Dep.; $2.00(cy), 1(mn) OTS.

The investigation of low and intermediate boiler compounds in OMRE coolants is discussed. Low boilers are defined for OMRE coolant as those compounds in the boiling range, 80 to 254°C, and intermediate boilers are defined as those in the range, 254 to 383°C. Nine of the 21 detectable low boilers were identified. These are benzene, toluene, ethylbenzene, m- and/or p-xylene, ethyltoluene, trimethylbenzene, n-propylbenzene, n-butylbenzene, and indane. Four of the 13 detectable intermediate boilers were identified as 3-methylbiphenyl, fluorene, phenanthrene, and fluorenone. The low boiler content of OMRE coolant ranged from 0.03 to 0.98 wt % with an average value of 0.74 wt % for OMRE Core I operation, and from 0.09 to 0.95 wt % with an average value of 0.52 wt % for Core II operation. During Core III, low boilers were below the limit of detection (<~0.005 wt % for the major low boilers). The intermediate boiler content of the coolant (determined by difference) was in the range from 3 to 10 wt % for OMRE Core I, from 6 to 13 wt % for OMRE Core II, and from −3.1 to 5.7 wt % for Core III. Some of the factors which affect the concentration of these decomposition products are discussed. The analyses of Core I, Core II, and Core III-A coolant samples for major coolant components, high boilers, and other minor components are presented. (auth)

4195 (NYO-10626) STUDIES ON THE EFFECT OF IRRADIATION ON CARBOHYDRATES. Final Report. Endre Endre A. Balazs (Retina Foundation, Boston). Nov. 1964. Contract AT(30-1)-2575. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Progress is reported in studies on the identity of a homogenous product with strong ultraviolet-absorbing properties formed during the high-energy x, γ, or electron irradiation of alkaline glucose solutions, glyceric acid, and various glucose derivatives; the electron spin resonance spectrum of γ-irradiated hyaluronic acid; and the physiochemical and biochemical properties of irradiated hyaluronic acid and vitreous gel from the eyeball of rabbits and sheep. (C.H.)

4196 (ORNL-3627(p.220-3)) RADIATION EFFECTS ON CATALYSTS. (Oak Ridge National Lab., Tenn.).

The effect of beta radiation on the catalytic decomposition of formic acid vapor was studied by the use of Cu, Ni, silica gel, activated alumina, zinc oxide, urania, thoria, silica-alumina, and chromia-alumina as catalysts. A beta-particle source containing 80 curies of $^{90}SrTiO_3$ was designed and constructed for these studies. Apparent activation energies were measured, and changes in product yields were sought. Analyses were carried out with a gas chromatograph used as an integral part of the catalyst irradiation apparatus. No permanent effects of beta irradiation were found with any of the catalysts. Transient effects were found with silica gel, zinc oxide, and urania. (auth)

4197 (SAN-8003(p.90-133)) COOLANT CHEMISTRY AND CORROSION. (San Francisco Operations Office, AEC).

The elimination of hydrogen and oxygen in high-pressure, high-temperature steam from a boiling-water reactor using commercial catalysts is discussed. Water chemistry measurements and a catalytic recombination experiment for BORAX V are reported. The Pathfinder chemistry and stress corrosion programs are discussed. Steam corrosion studies of Fe–Cr–Al–Y alloys in superheater environments are reported. Incoloy 800 fuel cladding corrosion and localized corrosion of type-304 SS and nickel-base alloys in superheated steam were studied. Oxidation products distributions during exposure to superheated steam were studied for 300-series SS and nickel-base alloys with and without heat transfer. The development of a digital readout programmed dissolved gas analyzer is reported. The EVESR chemistry programs are described. (R.E.U.)

4198 CONTRIBUTION TO THE STUDY OF DERIVATIVES OF BENZOFURAN AND NAPHTHOFURAN AS LIQUID SCINTILLATORS. Margareta Tibu, Ion Viscrian, Boris Arventiev, Hary Offenberg, and Tatiana Nicolaescu. Analele Stiint. Univ. A. I. Cuza, Iasi, Sect. I, 9: 261-70 (1963). (In Romanian)

The scintillation properties of eight compounds (4-methyl-2,3-diphenylbenzofuran; 5-methyl-2,3-diphenylbenzofuran; 6-methyl-2,3-diphenylbenzofuran; 7-methyl-2,3-diphenylbenzofuran; 4,7-dimethyl-2,3-diphenylbenzofuran; 5-chloro-2,3-diphenylbenzofuran; 4,5-diphenyl-(naphtho-1′,2′ : 2,3-furan); and 4,5-diphenyl-(naphtho-2′1′ : 2,3-furan)) were studied using toluene or p-xylene as solvents. The scintillation properties were compared with those of the compound PPO in toluene at the optimum concentration. The beta radiation of ^{137}Cs was used to excite the radioluminescent effect. The value of the anode current of the photomultiplier showed that the products studied probably have an emission a quantum less than that of PPO and the duration of the pulses is less than that of PPO. In p-xylene, the products have better scintillation properties. The absorption of the 6-methyl compound was found in the fluorescence zone of the toluene, and the photoluminescence spectra of the activators coincide in the region of maximum sensitivity of the photocathode. In the radioluminescence process, a fraction of the energy transmitted by the beta radiation is consumed. When quartz cuvettes are used, the radioluminescence effect of the quartz under the action of beta radiation is seen. (tr-auth)

4199 UTILIZATION OF THE RELATION BETWEEN THE LINEAR ENERGY TRANSFER AND RADIO-CHEMICAL YIELDS FOR THE DOSIMETRY OF IONIZING RADIATION SOURCES. M. V. Vladimirov. At. Energ. (USSR), 17: 222-4(Sept. 1964). (In Russian)

General empirical laws for the dependence of the H_2 and Fe^{3+} radiolysis yields in sulfuric acid exposed to ionizing radiation on the radiation LET are found from previously determined experimental values. The use of these relations for the dosimetry of radiation sources, especially external alpha sources, is demonstrated. (M.J.T.)

4200 ESTIMATION OF ELECTRON ENERGY DISTRIBUTION FROM INCREASE OF RARE GASES RADIOLUMINESCENCE IN THE ELECTRIC FIELD. A. Szymański and M. Kryszewski (Technical Univ., Lodz, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 513-16(1964).

The increase in luminescence of rare gases excited by ionizing radiation in an electric field was used to study electron energy distribution in the gases. Calculations indicated that the energy distribution is Maxwellian. (M.C.G.)

4201 ACTION OF HYDROXYLAMINE ON REDUCING SUGARS AND THE EFFECT OF BACKGROUND RADIATION ENERGY. Nganshou Wai and Shuh-ming Chang. Bull. Inst. Chem. Acad. Sinica, No. 9, 1-10(July 1964).

The quantity of glucose, fructose, or xylose reacted by

hydroxylamine was found to be affected by exposure to radiation. Through the same reaction period and under the same conditions, the reaction was compared in three different cases: in the space within a wooden box; in the space within a lead box of 16.5 cm wall thickness; and exposure to radiation from uranium acetate. In the lead box, the reaction quantity of reducing sugar was found to be greater than that within the wooden box. In irradiation by uranium, the reaction quantity was found to be less than that within the wooden box. The results indicate that radioactive energy favors the constitution of ring structure of glucose, fructose, and xylose. (auth)

4202 PARAMAGNETIC CENTERS FORMED BY γ IRRADIATION OF C_3 AND C_4 ALCOHOLS AT 77°K. Claude Chachaty (CEN, Saclay, France). Compt. Rend., 259: 2219-22(Oct. 5, 1964). (In French)

n-Propanol, allyl alcohol, and the four saturated butanols were irradiated with γ rays at 77°K. With the exception of allyl alcohol and tertiary butanol, their electron paramagnetic resonance spectra contain a unique band centered at $g = 2$ superposed on the spectra due to free radicals. The disappearance of this band in the presence of an electron captor or by exposure of the alcohols to visible light after irradiation makes possible its attribution to trapped electrons. (tr-auth)

4203 THE MECHANISM OF HYDROGEN FORMATION IN γ-IRRADIATED HYDROCARBONS. Sam Z. Toma and William H. Hamill (Univ. of Notre Dame, Ind.). J. Am. Chem. Soc., 86: 4761-4(Nov. 20, 1964).

The yields of cyclo-C_5H_8 and cyclo C_5H_{10} from radiolysis of mixtures of cyclo-C_5H_{10} and cyclo-C_6H_{12} were not linear in composition, unlike the yields of the corresponding cycloalkyl radicals. Additions of cyclo-C_6D_{10} to cyclo-C_6H_{12} decreased $G(H_2)$ and increased G(HD) in constant proportion. Yields of HD and D_2 from cyclo-C_6D_{12} and cyclo-C_6D_{10} as solutes were much less in ethanol than in alkanes. Radiolysis of 1,4-cyclo-C_6H_8 as solute in hydrocarbon solutions produced 1,3-cyclo-C_6H_8, cyclo-$C_6H_{7^+}$, and C_6H_6. All of these results were consistent with decomposition of molecular cations following electron return, loss of two hot hydrogen atoms, and formation of C=C and hot hydrogen. Alkane, alkene, and alkadiene produced alkene, diene, and triene, respectively. (auth)

4204 RADICAL SCAVENGING IN THE RADIOLYSIS OF LIQUID METHANOL–BENZENE MIXTURES. A. Ekstrom and J. L. Garnett (Univ. of New South Wales, Kensington, Australia). J. Am. Chem. Soc., 86: 5028-30 (Nov. 20, 1964).

A number of products from the radiolysis of methanol–benzene systems were separated and identified including biphenyl, anisole, and what is possibly a benzyl alcohol derivative. Changes in concentration of these products with benzene concentration were evaluated. Small concentrations of benzene resulted in a sharp increase in the concentration of radical-scavenged products and this was compensated by a sharp decrease in glycol yield. When the benzene concentration exceeded 10% by volume, the increase in concentration of radical scavenging products was reduced and becomes linear with benzene concentration to approximately 90%. (M.C.G.)

4205 DIFFERENCES IN THE BEHAVIOR OF BROMINE ISOTOPES ACTIVATED BY NEUTRON CAPTURE IN BROMOETHANE. T. E. Gilroy, George Miller, P. F. D. Shaw (Oxford Univ.). J. Am. Chem. Soc., 86: 5033-4 (Nov. 20, 1964).

Isotopic effects were observed in mixtures of bromoethane and bromine irradiated in the thermal column of British Experimental Pile O., at A.E.R.E., Harwell. Values are given for isotope ratios, established on the basis of several experiments, of the seven major products from neutron-irradiated bromoethane. The results indicated that di- and tribromoethane are more often formed with ^{82}Br than with ^{80m}Br and suggest that hydrogen atom substitution proceeds more readily through a mechanism involving Auger electron emission. (M.C.G.)

4206 KINETIC EVIDENCE FOR H_3O AS THE PRECURSOR OF MOLECULAR HYDROGEN IN THE RADIOLYSIS OF WATER. Thomas J. Sworski (Oak Ridge National Lab., Tenn.). J. Am. Chem. Soc., 86: 5034-5(Nov. 20, 1964).

It was found that the precursor of molecular hydrogen disappears by a first-order process following the radiolysis of water. Therefore, homogeneous kinetics can be substituted for diffusion kinetics to express the dependence of G_{H_2} on solute concentration. It is suggested that H_3O is the main precursor of the H_2 and disappears by 3 processes: $H_3O + H_2O \rightarrow H_{aq}^+ + e_{aq}^-$, $H_3O + H_3O \rightarrow H_2 + 2H_2O$, and $H_3O + OH \rightarrow 2H_2O$. (M.C.G.)

4207 ELECTRON SPIN RESONANCE STUDY OF RADICAL PAIRS TRAPPED IN IRRADIATED SINGLE CRYSTALS OF DIMETHYLGLYOXIME AT LIQUID-NITROGEN TEMPERATURE. Yukio Kurita (Toyo Rayon Co., Ltd., Kamakura, Japan). J. Chem. Phys., 41: 3926-7 (Dec. 15, 1964).

The ESR spectra of x irradiated single crystals of dimethylglyoxime were measured at 77°K. An analysis of the spectra revealed that two paramagnetic species are produced by the irradiation. One is an iminoxy radical $C(CH_3)NOH-C(CH_3)NO(\underline{M})$. The other, unstable at room temperature and containing two coupling nitrogen nuclei, is a radical pair with the mean distance between the two unpaired electrons of 5.6 Å. The absorption corresponding to the $\Delta\underline{M} = 2$ transition of the radical pair was observed in polycrystalline samples. The radical pair was tentatively identified to be the one consisting of adjacent radicals $\underline{M}\cdots\underline{M}$ along the crystallographic a axis. (auth)

4208 OPTICAL RADIATION FROM NITROGEN AND AIR AT HIGH PRESSURE EXCITED BY ENERGETIC ELECTRONS. G. Davidson and R. O'Neil (American Science and Engineering, Inc., Cambridge, Mass.). J. Chem. Phys., 41: 3946-55(Dec. 15, 1964).

The spectral characteristics and fluorescent efficiencies for electron excitation of nitrogen and air at 600 Torr were determined. Results are presented for the efficiency of conversion of electron energy to optical radiation in approximately one hundred resolved spectral components of air and nitrogen between 3200 and 10,800 Å when bombarded by 50-kev electrons. The total fluorescent efficiency under these conditions is $(0.14 \pm 0.02)\%$ for nitrogen and $(6.7 \pm 1.0) \times 10^{-3}\%$ for air. In nitrogen the first positive ($B\ ^3\Pi_g \rightarrow A\ ^3\Sigma_u^+$), second positive ($C\ ^3\Pi_u \rightarrow B\ ^3\Pi_g$), Gaydon green, Herman infrared, and Goldstein–Kaplan ($C'\ ^3\Pi_u \rightarrow B\ ^3\Pi_g$) band systems of N_2 and the first negative ($B\ ^2\Sigma_u^+ \rightarrow X\ ^2\Sigma_g^+$) band system of N_2^+ were observed. The (0–2) and (0–3) transitions of the Herman infrared system and $[N\ I]_{22}(^2D-^2P)$ forbidden doublet at 1.04 μ, previously unreported in the laboratory, were observed. In air the first positive and second positive band systems of N_2 and the first negative band system of N_2^+ were observed as well as atomic spectra of nitrogen, oxygen, and argon. (auth)

4209 GAS-PHASE RADIOLYSIS OF n-PENTANE. A STUDY OF THE DECOMPOSITIONS OF THE PARENT ION AND NEUTRAL EXCITED PENTANE MOLECULE. P. Ausloos and Sharon G. Lias (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 41: 3962-70(Dec. 15, 1964).

The direct and inert-gas-sensitized radiolyses of equimolar n-C_5H_{12} – C_5D_{12} – NO mixtures were investigated in the absence and presence of an applied electrical field. It is shown that the partially deuterium-labeled products remain essentially unchanged upon the application of an electrical field, while the yields of the fully deuterated and nondeuterated species increase indicating that the former entirely originate from ionic processes. Comparison of the ion-pair yields of these partially-labeled products, which can be ascribed mainly to hydride ion transfer from pentane to carbonium ions, with the ion-pair yields deduced from the 70-ev mass spectral pattern shows that, in the direct radiolysis, those fragment ions that are formed with a high activation energy are produced in a lower yield than in the mass spectrometer and are also reduced most strongly by an increase in pressure. In all experiments, both the propyl and butyl ions formed in the decomposition of the pentane ion acquire the secondary configuration

either prior to or during reaction. In the inert-gas-sensitized radiolysis, the fragment ions that were formed with a high appearance potential were seen to increase with an increase in the recombination energy of the added inert gas. From the applied-field experiments, it was possible to determine the modes of decomposition of neutral excited pentane molecules formed by electron impact. These were found to be analogous to those deduced from vacuum-ultraviolet photolysis experiments carried out at 1470 or 1237 Å. On the basis of the information gained from these experiments, and a detailed isotopic analysis of the products formed in the radiolysis both in the presence and absence of benzene, a value of 0.3 ± 0.05 could be deduced for the number of neutral excited molecule decompositions per ion pair. Neutral excited pentane molecules were also formed in the inert-gas-sensitized radiolysis. (auth)

4210 PARAMAGNETIC RESONANCE STUDY OF NO_3 IN IRRADIATED KNO_3. Ralph Livingston and Henry Zeldes (Oak Ridge National Lab., Tenn). J. Chem. Phys., 41: 4011-12(Dec. 15, 1964). (ORNL-P-138)

Single crystals of KNO_3 were irradiated at 77°K with ^{60}Co gamma rays for 10 min at a dose rate of about 2×10^{18} ev g^{-1} min^{-1} and the spectra immediately studied at 77°C. A family of three paramagnetic resonance lines, which likely arise from NO_3, were found. The triplet structure undoubtedly arises from weak hyperfine coupling with a single ^{14}N. The principal g values are $A_{||}$ = 12.08 ± 0.15 Mc/sec and $A_{\perp}$ = 9.80 ± 0.15 Mc/sec (corresponding to 4.31 and 3.46 G, respectively). (P.C.H.)

4211 RADIOCHEMICAL POLYMERIZATION OF SEVERAL VINYL COMPOUNDS IN SOLID MIXTURES WITH PARAFFIN OIL. Adolphe Chapiro and Maria Pertessis (CNRS, Bellevue, France). J. Chim. Phys., 61: 991-8(July-Aug. 1964). (In French)

The radiochemical polymerization of methyl methacrylate (MMA), methyl acrylate (MA), vinyl acetate (VA), and styrene in solid mixtures with paraffin oil was studied at −78°C. In the case of MMA, the reaction is very rapid. The conversion curves have a long linear portion whose slope is maximum for the mixtures containing 10% of the monomer. The molecular masses of the polymer obtained follow an analogous law. The reaction is inhibited by oxygen, as well as by other interceptors of free radicals. This suggests that the polymerization proceeds by a radical mechanism. The radiochemical yield of radicals that have effectively initiated polymerization chains was calculated beginning with the velocities and molecular masses. This yield has a maximum for a 15% content of MMA in the solid mixture; for this content G(R) = 1.44. These yields were compared with the values deduced from electron paramagnetic resonance measurements in the same mixtures. The three other monomers examined have kinetic characteristics analogous to those obtained for MMA; the polymerization velocity is maximum for sufficiently low contents of the monomer in the mixture. The reaction is much slower, however, in these systems. The role played by the paraffin oil in these reactions is discussed in the light of these results. (tr-auth)

4212 STUDY BY ELECTRON PARAMAGNETIC RESONANCE OF ELECTRONS AND RADICALS TRAPPED IN ALCOHOLS IRRADIATED BY γ RAYS AT 77°K. Claude Chachaty and Elie Hayon (CEN, Saclay, France). J. Chim. Phys., 61: 1115-28(July-Aug. 1964). (In French)

The centers created by γ irradiation of glasses of methanol, ethanol, and isopropanol at 77°K were studied by electron paramagnetic resonance. These glasses are colored by irradiation, and the electron paramagnetic resonance spectrum consists of a single ray centered in the vicinity of g = 2 superposed on the spectrum of radicals resulting from the extraction of a hydrogen atom from the carbon having the OH group. The addition before irradiation of a certain number of electron captors, such as acids and halogenated or aromatic compounds, suppresses this single ray and modifies or causes the coloration to disappear. The results suggest that the single ray obtained by γ irradiation of the different alcohols and absorption in the visible light domain are due to electrons coming from the ionization of the alcohols and trapped in the glasses. The effects of visible and uv light on these paramagnetic centers formed by γ irradiation and the formation of some alkoxy and peroxy radicals were studied. (tr-auth)

4213 THE RADIOLYSIS OF AQUEOUS PERCHLORIC ACID SOLUTIONS. D. Katakis and A. O. Allen (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 68: 3107-15 (Nov. 1964). (BNL-7527)

The radiolysis of aqueous perchloric acid solutions was studied as a function of concentration in the absence and presence of radical scavengers. Free radicals from water radiolysis appear not to react with perchlorate ion. Perchlorate decomposes, as reported by others, by the direct action of radiation, with a yield increasing directly with its concentration, while the yields of H_2 and other water decomposition products decrease. The major product of perchlorate ion decomposition is chlorate; most of the chloride formed arises from secondary decomposition of the chlorate ions. Excited perchlorate ions appear mainly to decompose, not to electrons and ClO_4 radicals, but to chlorate ions and oxygen atoms. (auth)

4214 TRITIUM β-RADIATION-INDUCED ISOTOPIC EXCHANGE WITH WATER VAPOR. John Y. Yang and L. H. Gevantman (Naval Radiological Defense Lab., San Francisco). J. Phys. Chem., 68: 3115-19(Nov. 1964).

The rate of tritium β-decay-induced isotopic exchange between tritium gas and water vapor was found to be constant within a fourfold variation in the water vapor density, but to increase as a second-order function of the tritium concentration. Inert gases, present in large excess, appeared to function purely as moderating media for the tritium β-energy. With helium gas as the moderator and tritium concentration in the range from 0.05 to 0.7 C/l, the reaction rate in mC/l/day at the ambient temperature of 22 ± 2° was observed as $d(HTO)/dt = 3.6 \times 10^{-5}(T_2)^2$, where (T_2) is the initial tritium concentration in mC/l. This exchange reaction is strongly inhibited by the presence of nitric oxide in the reaction mixture. The results are consistent with a reaction mechanism involving radical intermediates. (auth)

4215 OXIDATION OF HYDROCARBONS ADSORBED ON OXIDE CATALYSTS INDUCED BY COBALT-60 γ-RAYS. Harold W. Kohn (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 68: 3129-36(Nov. 1964).

Radioinduced oxidation of seventeen hydrocarbons adsorbed on silica gel, alumina, and aluminosilicate catalysts was studied manometrically and by gas chromatography of oxidation product extracts. Oxygen consumption was lowest for saturated hydrocarbons on silica gel (e.g., $G(-O_2)_{methane} \cong 1$ molecule/100 ev absorbed) and highest for unsaturated hydrocarbons on alumina (e.g., $G(O_2)_{hexene\text{-}1} \cong 100$ molecules/100 ev absorbed). Based on results for two hydrocarbon-adsorbent-oxygen systems, oxidation yields were shown to be temperature independent from −195°C to room temperature and to decrease with decreasing oxygen pressure and with decreasing surface coverage. Toluene oxidation products (identified by gas chromatography) were benzyl alcohol, phenol, and cresols. Xylenes, given the same treatment, yielded similar products. Toluene–alumina, when irradiated in vacuo, gave smaller amounts of the same products than those which contained oxygen. A postirradiation reaction followed nearly all these irradiations. A system of kinetics was developed for this postirradiation reaction. An initial step is postulated involving oxidation of the adsorbate and simultaneous reduction of the adsorbent, followed by the regeneration of the catalyst by gaseous oxygen. High G values for oxygen consumption in most systems indicate a surface chain and/or reaction of several oxygen molecules with the organic compound to give undetected products. (auth)

4216 ISOTOPE EFFECTS IN THE HYDROGEN ABSTRACTION FROM ALIPHATIC COMPOUNDS BY RADIOLYTICALLY PRODUCED HYDROGEN ATOMS IN AQUEOUS SOLUTIONS. M. Anbar and D. Meyerstein (Weizmann Inst. of Science, Rehovoth, Israel and Soreq Research Establishment, Rehovoth, Israel). J. Phys. Chem., 68: 3184-7(Nov. 1964).

The isotope effect on the abstraction of the α-hydrogen of 2-propanol by hydrogen atoms was determined. An identical isotope effect $k_{H\alpha}/k_{D\alpha} = 7.5 \pm 1$ was found both in neutral and acid solutions, indicating the identity of the residual hydrogen with hydrogen atoms. The reactivity of the α-hydrogen in 2-propanol toward hydrogen atoms was found to be 110 times higher than that of the β-hydrogens. The isotope effects on hydrogen abstraction by hydrogen atoms from formate, methanol, and acetate were determined and found to be 6.5 ± 0.5, 20 ± 1, and 22 ± 4, respectively. The high values for the H-D isotope effect were obtained for hydrogen abstraction reactions of a relatively low rate, where a tunneling effect may be involved. (auth)

4217 RADIOLYSIS OF CYCLOHEXENE. III. CYCLOHEXENE-d_{10}. B. R. Wakeford and G. R. Freeman (Univ. of Alberta, Edmonton). J. Phys. Chem., 68: 3214-18(Nov. 1964).

The γ radiolysis of liquid cyclohexene-d_{10} gave the following product yields. The corresponding yields from light cyclohexene are given in parentheses: hydrogen, 0.65 (1.28); cyclohexane, 0.66 (0.95); 2,2′-dicyclohexenyl, 1.36 (1.90); 3-cyclohexylcyclohexene, 0.66 (0.58); dicyclohexyl, 0.47 (0.21); unidentified dimer, 0.32 (0.22). The overall rate of decomposition of cyclohexene-d_{10} was quite similar to that of light cyclohexene, although the product distribution was quite different. Moderately large isotope effects (~ 3.6) were evident in the overall radiolytic reaction. Considering the activated species that produce hydrogen, activation transfer occurs from the c-C_6D_{10} species to c-C_6H_{10}, as well as to 1,3- and 1,4-cyclohexadiene and to benzene. (auth)

4218 THE RADIATION CHEMISTRY OF ORGANIC LIQUID MIXTURES. [PART] II. J. F. Merklin and S. Lipsky (Univ. of Minnesota, Minneapolis). J. Phys. Chem., 68: 3297-3306(Nov. 1964).

Studies were made on the hydrogen yields produced by γ irradiation of: mixtures of benzene with the cycloalkanes: methylcyclohexane, ethylcyclohexane, and bicyclohexyl; mixtures of benzene with the arylcycloalkanes: 1-methyl-4-phenylcyclohexane and 1-phenyl-2-cyclohexylethane; and mixtures of methylcyclohexane and ethylcyclohexane with their respective aryl derivatives: 1-methyl-4-phenylcyclohexane and 1-phenyl-2-cyclohexylethane. Both methylcyclohexane and ethylcyclohexane exhibited sharp reduction in their hydrogen yields on addition of traces of benzene. The mechanism responsible for this effect seemed to saturate at about 0.05 M benzene, and further addition of benzene reduced the hydrogen yield with much lower efficiency. The effect at low concentration was attributed to scavenging of thermal H atoms by benzene, and on the basis of this assumption a kinetic analysis led to calculated thermal H atom yields at zero dose of $G(H) = 1.4 \pm 0.4$ for methylcyclohexane and $G(H) = 2.3 \pm 0.4$ for ethylcyclohexane. The protection efficiency at high benzene concentrations in both liquids was found to be the same as exhibited by benzene in cyclohexane mixtures at all benzene concentrations suggesting that thermal H atoms are produced with yield not exceeding 0.2 ± 0.4 in radiolysis of cyclohexane. A comparison of the dose dependence of $G(H_2)$ from cyclohexane, methylcyclohexane, and ethylcyclohexane is consistent with this interpretation. For cycloalkane-arylcycloalkane mixtures at high arylcycloalkane concentrations, the protective effect was qualitatively similar to that exhibited by benzene. However, at low concentrations, the arylcycloalkane was much less efficient than benzene in reducing $G(H_2)$ in methylcyclohexane and ethylcyclohexane. A comparison was made of $G(H_2)$ from pure arylcycloalkane liquid with $G(H_2)$ from physical mixtures of benzene and the corresponding cycloalkane at equivalent electron fractions. In all cases, the yield from the mixture was at least two times greater than from the pure compound. (auth)

4219 GEL DOSIMETRIC SYSTEM WITH TRICHLOROETHYLENE AND BROMOCRESOL PURPLE. Yu. D. Skoropad. Med. Radiol., 9: No. 10, 77-81(Oct. 1964). (In Russian)

A technique involving preparation, irradiation, and optical analysis of a gel dosimetric system with trichloroethylene and bromocresol purple is described. An example of the utilization of a gel dosimeter in measuring dose field section is given. (auth)

4220 CHEMICAL EFFECT OF NEUTRON CAPTURE II. INFLUENCE OF ULTRASONICS ON NEUTRON IRRADIATED AMMONIUM SULFATE AND POTASSIUM SULFATE. Nikola Getoff (Institut für Radiumforschung und Kernphysik, Vienna). Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 10, 211-19(1963). (In German)

The effects of ultrasonics on the reversal of neutron-induced defects were studied in potassium sulfate and ammonium sulfate crystals. The crystals were exposed to reactor neutron beams and then to ultrasonics. The experimental results indicate that ultrasonics produce two processes, photochemical heating and a decomposition process (phonolysis) in potassium sulfate. In ammonium sulfate the reducing effects of hydrazine formed by radiation and photochemical processes were evident. (J.S.R.)

4221 FORMATION OF COLOUR CENTRES IN IRRADIATED ALKALINE ICE. P. N. Moorthy and J. J. Weiss (The University, Newcastle-upon-Tyne, Eng.). Phil. Mag. (8), 10: 659-74(Oct. 1964).

The different paramagnetic species—OH radicals, O^- ions and trapped electrons—formed in the radiolysis (^{60}Co gamma rays) of frozen aqueous solutions of alkali hydroxide at 77°K were studied using electron spin resonance (ESR) techniques. Trapping of electrons in irradiated alkaline ice was interpreted as a consequence of the reaction of the radiation produced hole (designated by $(H_2O)^+$) according to $(H_2O)^+ + OH^- \rightarrow OH + H_2O$, thus inhibiting to a greater or lesser extent the recombination between the primarily produced electrons and holes. The OH radicals, formed by the above reaction as well as those from the direct action of the radiation on water, are converted to O^- radical ions by the proton transfer reaction $OH + OH^- \rightarrow O^- + H_2O$. The experimental results indicate that electrons are trapped in a vacant orbit around the O^- radical ions. Such a mechanism also gives the correct dependence of the yields of the different species on the alkali concentration. The widths of the ESR line of the trapped electron in the H_2O and D_2O systems agree with the values calculated on the basis of a model in which the electron is delocalized over about four water molecules, giving rise to an inhomogeneously broadened envelope of the individual unresolved nuclear hyperfine lines. The observed negative g-factor shifts suggest that excited levels of the alkali cations which bound the vacancy also contribute to the ground-state wave function of the trapped electron somewhat similar to the case of the F-centers in alkali halide crystals. (auth)

4222 THE EFFECT OF CRYSTALLIZATION CONDITIONS ON RADIATION-INDUCED CROSS-LINK FORMATION IN POLYETHYLENE. T. Kawai (Univ. of Bristol, Eng.), A. Keller, A. Charlesby, and M. G. Ormerod. Phil. Mag. (8), 10: 779-84(Nov. 1964).

Preliminary conclusions concerning the differences in the radiation-induced gelation behavior between bulk and single crystals and the effect of lamellar packing in various single crystal preparations of polyethylene were substantiated by an extensive systematic examination. Smaller but analogous differences in behavior were also found between specimens melt crystallized under different conditions. The effect of primary crystallization conditions and that of annealing on gelation, as well as of existing cross-links on subsequent annealing were also examined. The solubility measurements were supplemented by measurements of intrinsic viscosity, of the amount of hydrogen evolved, and, to a greater extent, by electron spin resonance examination of radical concentrations and decay rates. It was found that the folds are preferred sites of reaction, cross-linking occurring either between the folds belonging to different lamellae or within the folds in the same lamellae dependent on the quality of interlamellar contact. Attention is drawn to the fact that radiation-induced gelation could potentially be used for characterizing molecular coordination in polymers. (auth)

4223 NEW POSSIBILITIES OF ACCELERATING THE CHEMICAL REACTIONS IN IONIZING FIELDS. L. I.

Ciplea. Rev. Chim. (Bucharest), 14: 296-8(May 1963). (In Romanian)

A new possibility of raising the efficiency of chemical reactions initiated by means of ionizing radiations is emphasized. The principle of the method consists of accelerating—in variable electric or magnetic fields—the electrons and ions produced by the ionizing action of nuclear radiations. (auth)

4224 THE RADIOLYSIS OF METHANOL BY $^{10}B(n,\alpha)^{7}Li$ RECOILS. THE EFFECT OF LINEAR ENERGY TRANSFER ON THE RADIOLYSIS OF METHANOL. Masashi Imamura. Rika Gaku Kenkyusho Hokoku, 40: 176-84(1964). (In Japanese)

4225 STUDY OF THE EFFECT OF NUCLEAR RADIATION ON THE CATALYTIC PROPERTIES OF MnO_2. H. Otwinowska, A. Nowacki, and S. Ciborowski. Roczniki Chem., 38: 1007-12(1964).

The catalytic activity of MnO_2 was studied after irradiation with a fast neutron flux ($10^{17} - 10^{18}$ n), γ rays from a ^{60}Co source (4000 C), and an accelerated proton flux. The MnO_2 activity was tested on CO oxidation and H_2O_2 decomposition. The most pronounced changes were due to neutron irradiation, which resulted in a threefold decrease of MnO_2 catalytic activity in CO oxidation and a twofold increase in H_2O_2 decomposition. The neutron and proton fluxes caused a γ-β phase transition. Structural changes in the catalyst were similar to those due to roasting at 350°C. There was no observable effect of γ irradiation. (OTS)

4226 ON EXPLANATION OF EXPERIMENTAL DATA ON DYNAMIC POLARIZATION OF PROTONS IN IRRADIATED POLYETHYLENES. A. V. Kessenikh, A. A. Manenkov, and G. I. Pyatnitskii (Karpov Inst. of Physics and Chemistry, Moscow.) Soviet Phys.-Solid State (English Transl.), 6: 641-3(Sept. 1964). Translated from Fiz. Tverd, Tela, 6: 827-30(Mar. 1964).

The results are given of some quantitative calculations of the dynamic polarization factor η on the magnetic field within the framework of the phenomenological theory of inhomogeneous EPR broadening with cross-relaxation taken into account. The results of approximate calculations are in satisfactory agreement with the experimental data for the DPN in irradiated polyethylenes, both in order of magnitude and in the nature of the temperature dependence. (auth)

4227 RADIOAKTIVNYE IZOTOPY TSIRKONIYA I NIOBIYA $Zr^{95}-Nb^{95}$ I $Zr^{97}-Nb^{97}$. (Radioactive Isotopes of Zirconium and Niobium: $^{95}Zr-^{95}Nb$ and $^{97}Zr-^{97}Nb$). N. P. Rudenko and O. M. Kalinkina. Moscow, Atomizdat, 1964. 28p.

Abundances of the stable isotopes of niobium and zirconium are tabulated. The half-life, type of decay, energy of radiations, and method of preparation of radioactive isotopes are tabulated. The preparative methods, both nuclear and chemical, are discussed, and uses are briefly considered. (IIC—M.G.)

4228 NOVYE ELEMENTY V PERIODICHESKOI SISTEME D. I. MENDELEEVA. (New Elements in the Periodic Table of D. I. Mendeleev). V. I. Gol'danskii. Moscow, Atomizdat, 1964. 280p.

Preparation and separation of new elements are discussed, and the relation between atomic structure and chemical properties is analyzed. The synthesis of technetium, promethium, astatine, and francium and the properties of transuranium elements are described. (R.V.J.)

4229 IRRADIATION TEMPERATURE DEPENDENCE OF ESR SPECTRA IN IRRADIATED ORGANIC COMPOUNDS. Harold G. Freund (Roswell Park Memorial Inst., Buffalo). 8p. (CONF-452-63)

From American Physical Society, Washington, D. C., Apr. 1964.

In ESR studies on the irradiation of amino acids and peptides, it was found that the temperature at which irradiation takes place may have a bearing on the spectrum obtained. For example, irradiation of valine at liquid nitrogen temperature produces a simpler spectrum than that obtained from a room temperature irradiation. The difference is probably due to the suppression of certain radical species that are formed preferentially at higher temperatures. Glycylglycine, irradiated at low temperature, yields a resolved four-line spectrum instead of the usual broad doublet pattern. Several other amino acids and peptides, including cystine and glycine, were studied in the form of single crystals and the effect of irradiation temperature on their spectra is discussed. (auth)

4230 DEGRADATION OF POLYETHYLENE TEREPHTHALATE BY γ-RADIATION. S. D. Burow (Research Triangle Inst., Durham, N. C.), D. T. Turner, George F. Pezdirtz, and George D. Sands. 15p. (CONF-571-17)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Polyethylene terephthalate was exposed in vacuo to ^{60}Co γ radiation at a dose rate of 0.02 MRad/min with an ambient temperature of 47°C. Gaseous products were analyzed in a mass spectrometer and carboxyl groups by titration with NaOH. Initial G values were $-COOH = 0.77$, $CO_2 = 0.17$, $CO = 0.11$, $H_2 = 0.015$, and $CH_4 = 0.003$. All these values decreased with increasing dose except $G(CO_2)$ which, roughly, was sustained up to 5000 MRad. The relatively high value of G(−COOH) is attributed to thermal degradation, invoking the point heat theory of Dessauer. Extensive branching is diagnosed in the completely soluble irradiated polymer by comparison of yields of chain fractures estimated from solution viscosity, osmometry, and end-group analysis data. Gamma irradiation differs from electron-irradiation in that crystallinity of the sample is largely retained, as evidenced by infrared and x-ray diffraction data, and in that no gelation occurs up to a dose of 5000 MRad. Support for the view that these differences are due to a higher ambient temperature during electron irradiation was obtained when samples heated to 245°C during γ irradiation were found to contain 33% gel after a dose of only 172 MRad. (auth)

4231 PROCESS OF CYANOETHYLATING COTTON FIBERS AND GRAFT POLYMERIZING THERETO ACRYLONITRILE WITH IONIZING RADIATION. Jett C. Arthur, Jr. and Robert J. Demint (to Dept. of Agriculture). U. S. Patent 3,157,460. Nov. 17, 1964. Filed Nov. 25, 1960.

A method of preparing graft polymers of acrylonitrile with cyanoethylated cotton is described. The yarn, 4 parts substituted, was treated with a solution of 32 parts acrylonitrile monomer, 54 parts $ZnCl_2$, and 14 parts H_2O, then irradiated to 1,000,000 roentgons from Co-60. The polymer formed was removed at 25°C by N, N-dimethyl formamide. (T.R.H.)

Radiochemistry

4232 (IDO-17007) SEPARATION AND PURIFICATION OF A GRAM OF PROTACTINIUM-233. J. W. Codding, J. R. Berreth, R. P. Schuman, W. H. Burgus, and R. A. Deal (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 1964. Contract AT(10-1)-205. 32p. Dep.; $2.00(cy), 1(mn) OTS.

One gram (20,000 Curies) of pure protactinium-233 has been separated from irradiated thorium and prepared as a sample for neutron cross section measurements with the MTR Fast Chopper. Development of the process is described. Irradiated thorium was dissolved in nitric–hydrofluoric acid. Separation of protactinium from thorium, uranium, and most fission products was obtained by three successive co-precipitations with MnO_2, each of which carried about 90% of the ^{233}Pa. Manganese was subsequently removed by leaching the final Pa-bearing MnO_2 with dilute nitric acid plus hydrogen peroxide, leaving behind a hydrated Pa oxide, which was then dissolved by prolonged digestion with sulfuric acid. Final recovery was by addition of iodic acid, which precipitated Pa iodate. This was dried and fired at 800°C to Pa_2O_5. Overall ^{233}Pa recovery was about 50%. Chemical analysis, gamma counting, and neutron absorption measurements showed the absence of thorium, initial uranium, manganese, or other impurities in the final product. (auth)

4233 (NRS-19) POSITRONIUM CHEMISTRY IN LIQUIDS. I. THEORETICAL. S. J. Tao and J. H. Green (New South Wales, Australia. Univ., Kensington). 1964. 25p. Dep.(mn).

A theory of positronium chemistry in liquids is proposed. The first part discusses the mechanism of slowing down of positrons, their fate in condensed media, and the annihilation lifetimes of positrons in different states. Positronium behaves like a "hot" H radical in liquids with some specific features caused by its light mass and short life. The nature and energetics of several kinds of positronium chemical reactions are discussed, in general terms, after showing that the Ore gap concept is not applicable. (auth)

4234 THE METHOD OF DETERMINATION OF THE DIFFUSION COEFFICIENT OF SOME OF THE β RADIOACTIVE SUBSTANCES IN SOLID BODIES. C. Balcerzak. Ann. Acad. Med. Lodz, No. 3, 3-11(1963).

A method of determining the diffusion coefficient of a β-active isotope with a simple low-energy spectrum is described. The method is based on a measurement of β intensity in solid bodies from which an x-constant layer is cut. Intensity is measured at various times. The diffusion coefficient is given by the formula $D = x^2/4B$ where: x is the depth at which the measure is made, B is a constant obtained from the β intensity of a Δx layer. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4235 MEASUREMENTS OF RaA DIFFUSION COEFFICIENT BY PRECIPITATION FROM LAMINAR CURRENT. V. I. Korpusov, B. I. Ogorodnikov, and V. N. Kirichenko. At. Energ. (USSR), 17: 221-2(Sept. 1964). (In Russian)

The coefficient of ^{218}Po diffusion was determined, using the method of precipitation from a laminar flow of air and ^{222}Rn in a cylindrical channel and measurement of the radioactivity of the precipitate. A graph of the variation of the ^{218}Po β count rate per unit pipe length with the average flow rate is given. The coefficient of diffusion, 0.068 ± 0.004 cm^2/sec, was obtained using a formula derived in terms of the average flow rate and the number of ^{218}Po atom. (M.J.T.)

4236 GRAPHIC ANALYSIS OF RADIOACTIVE DECAY OF MOTHER AND DAUGHTER ISOTOPES. S. G. Malakhov. At. Energ. (USSR), 17: 226(Sept. 1964). (In Russian)

A method for analyzing the activity of two-component mother-and-daughter mixtures of radioisotopes is described. A simple graphic solution of the developed equations is explained, and the example of analysis of a ^{95}Zr+^{95}Nb mixture is given. (M.J.T.)

4237 BIOSYNTHESIS OF THIAMINE: ISOLATION OF A DIAMINE RADIOACTIVE IN C_4. Serge David and Bernard Estramareix (Université, Nancy). Bull. Soc. Chim. France, No. 8, 2023-4(Aug. 1964). (In French)

Yeast was cultivated in the presence of ^{14}C-formate, and the thiamine was extracted on an exchange column. The solution was deaminated, and the intermediary product 2-methyl 4-pyrimidine methyl-5-thioacetic acid was crystallized. The acid was dissolved in alcohol, and a diamine radioactive in C_4 was distilled. The picrate of 1,3-diamine 2-methyl propane was crystallized from the distillate and appears to be almost pure. (J.S.R.)

4238 PAPER CHROMATOGRAPHIC SEPARATION OF CALCIUM, STRONTIUM, BARIUM AND THORIUM, G. C. Saxena and D. R. Singh (Balwant Rajut Coll., Agra, India). Indian J. Chem., 2: 456-7(Nov. 1964).

Paper chromatographic separation of a mixture containing calcium, strontium, barium, and thorium was achieved using 8N ammonium hydroxide for running the chromatograms. Barium and strontium were identified by spraying with 2 per cent freshly prepared aqueous solution of sodium rhodizonate whereas calcium and thorium were identified by spraying with a saturated solution of alizarin in alcohol (96%) and exposing to ammonia and acetic vapors. (auth)

4239 DEVICE FOR THE ELECTROLYTIC-MELT REFINING OF REACTOR METALS, ESPECIALLY URANIUM AND PLUTONIUM. Joseph Gerard Wurm (to Euratom). German Patent 1,176,375. Aug. 20, 1964. Filed Sept. 13, 1962.

Electrolysis is carried out in a gas-tight reaction container. Halogen salts of the metals are the electrolyte, the cathode is made of the pure, liquid metal, and the anode consists of the impure, solid material. The electrolyzer includes a metallic, electrically conducting vessel, e.g., of copper, in which electrolysis takes place. This vessel, which is especially prepared for induction heating, is surrounded by an induction coil. (Gmelin Inst.)

Separation Processes and Procedures

4240 (DP-930) RADIOCHEMICAL SEPARATIONS PLANT STUDY. LIMITED MAINTENANCE—CASE VII. Robert J. Christl, John E. Crawley, and Clifford S. Otto (Du Pont de Nemours (E. I.) & Co. Mfg. Div., Wilmington, Del.). Sept. 1964. Contract AT(07-2)-1. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A conceptual design and estimate for a "limited maintenance" radiochemical separations plant for processing irradiated nonproduction reactor fuels have been prepared to supplement the cases presented in Report DP-566. (auth)

4241 (EUR-1913.i) SEPARAZIONE CON SOLVENTI DEI PRODOTTI DI DISSOLUZIONE NITRICA DEL CARBURO D'URANIO. (Solvent Separation from the Products of Nitric Dissolutions of Uranium Carbide). F. Mannone, C. Stoppa, and G. Sanso (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 25p. Dep.(mn).

The separation of uranium from the products of nitric dissolution of uranium carbide has been experimentally tested by a solvent extraction process. Uranium monocarbide ($UC_2 \leq 2\%$) was completely dissolved at 80°C in 4M, 8M, and 11M nitric acid and a solution of nitric acid, uranyl nitrate, and dark-brown products, was obtained. The solution of uranium carbide in 11M nitric acid has been extracted with 20% trilaurylamine nitrate in dodecane in order to separate the uranium and to check its distribution coefficients. The solutions of uranium carbide in 4M and 8M nitric acid have been used to study the effect of the nitric acid on the extraction of the dark-brown products in the solvents (20% trilaurylamine in dodecane). All batch tests were performed at room temperature. The results obtained show that: (a) A good separation of uranium from the dark-brown products can be achieved by extraction with trilaurylamine provided the nitric concentration of initial aqueous phase is not lower than 6M. The organic phase must be pre-equilibrated with nitric acid in order to avoid any transfer of nitric acid from the aqueous phase to organic phase during the uranium extraction. The dark-brown products will remain in the aqueous wastes. (b) The presence of dark-brown products has no influence on the distribution coefficient of uranium. (c) An addition of aluminium nitrate to a nitric acid solution will reduce the extraction of the dark-brown products. The stoichiometrical substitution of nitric acid with aluminum nitrate in respect to nitrate ion concentration has a less negative effect on this extraction. (auth)

4242 (HW-84101) SUPPLEMENTAL STUDIES ON THE SEPARATION OF CERIUM(IV) FROM THE TRIVALENT RARE EARTHS. L. A. Bray and F. P. Roberts (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1964. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The separation of cerium from trivalent rare earths, by oxidation of cerium with persulfate ion in the presence of silver and extraction with 0.4M D2EHPA, 0.2M TBP in a branched chain, hydrocarbon diluent (SOLTROL-170), is improved by the substitution of a purified straight chain hydrocarbon diluent with 10–14 carbon atoms in the chain (known as NPH, or normal paraffin hydrocarbon). The effect of radiolysis is diminished and higher distribution

ratios are obtained. Data obtained on the preoxidation of Ce(III) to Ce(IV) prior to contact with the organic show cerium distribution ratios of greater than 100 after 10 minutes of contact when 0.1M $K_2S_2O_8$, 0.02M silver, and 2M HNO_3 are present in the aqueous phase. Lower concentrations of either silver or persulfate result in marginal distribution ratios. Addition of HEDTA to rare earth solutions prevent precipitation of rare earth double sulfates at pH values greater than about 2.8 while still permitting extraction and hence separation from sulfate. Distribution ratios for silver under these conditions are generally quite low. (auth)

4243 (IDO-14645) ZIRCONIUM PROCESSING CAPABILITY OF THE IDAHO CHEMICAL PROCESSING PLANT. J. R. Bower (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1964. Contract AT(10-1)-205. 17p. Dep.; $1.00(cy), 1(mn) OTS.

A versatile hydrofluoric acid dissolution process enables the Idaho Chemical Processing Plant to process zirconium- or Zircaloy-clad zirconium–uranium fuels. Use of dissolved boron for nuclear criticality control permits high capacity semi-continuous operation. The Monel dissolver and austenitic stainless steel waste storage tanks satisfactorily resist corrosion by the process solutions. The resulting high-level waste solutions can be converted to granular solids by fluidized bed calcination. (auth)

4244 (IS-942) SOME BIS(DIALKYLPHOSPHINYL)-METHANES AS SOLVENT EXTRACTANTS. James Roger Parker and C. V. Banks (Ames Lab., Ames, Iowa). June 1964. Contract W-7405-eng-82. 191p. Dep.; $5.00(cy), 3(mn) OTS.

An extensive review of some of the more important neutral organophosphorus compounds as solvent extractants was given. The compounds included were tri-n-butyl phosphate, TBP, tri-n-octylphosphine oxide, TOPO, tris(2-ethylhexyl)phosphine oxide, TEHPO, and bis(di-n-hexylphosphinyl)methane, HDPM. A review was also given on the effects of structure on the extracting power of neutral organophosphorus compounds. It was found that many phosphoryl containing compounds could be titrated as bases. By studying the extraction of nitric acid, a relative order of basicity was established for certain of the phosphine oxides. TOPO was found to be more basic than TEHPO, and HDPM was found to be more basic than bis(di-2-ethylbutylphosphinyl)methane, EBDPM, which in turn was more basic than bis(di-2-ethylhexylphosphinyl)-methane, EHDPM. The extraction of uranium(VI) nitrate, thorium nitrate, and samarium nitrate by TOPO, TEHPO, HDPM, EBDPM, and EHDPM was studied as a function of nitric acid concentration. From an examination of the distribution coefficients obtained, a number of generalizations were made: (1) bis(dialkylphosphinyl)methanes are better extractants than trialkylphosphine oxides; (2) compounds with straight-chain alkyl groups are better extractants than those with branched-chain alkyl groups for both the bis(dialkylphosphinyl)methanes and the trialkylphosphine oxides; (3) trialkylphosphine oxides and the more sterically hindered bis(dialkylphosphinyl)methanes are better extractants for uranium(VI) nitrate than for thorium nitrate; and (4) nonsterically hindered bis(dialkylphosphinyl)-methanes are better extractants for thorium nitrate than for uranium(VI) nitrate. Uranium(VI) nitrate and thorium nitrate can be quantitatively extracted by any of the reagents while samarium nitrate is extracted to a much lesser extent. Because highly basic phosphoryl groups are of little value in coordinating a metal atom if the groups are sterically hindered, it was of interest to see if any of the extractants being used showed evidence of having rotational isomers. The infrared spectra of the extractants were obtained. The phosphoryl band was a doublet in at least some of the spectra. It was found that the relative intensities of the two bands of the phosphoryl doublet were temperature dependent. This gave evidence for the existence of rotational isomers for EBDPM, EHDPM, and TEHPO. However, no confirming evidence could be found in their proton magnetic resonance spectra. The structures of the complexes formed between thorium nitrate and TOPO, TEHPO, HDPM, and EBDPM were determined using saturation, equilibrium, infrared, and conductivity studies. The complexes found to exist in solution were $Th(NO_3)_4 \cdot 2TOPO$, $Th(NO_3)_4 \cdot 3TOPO$, $Th(NO_3)_4 \cdot 2TEHPO$, $Th(NO_3)_4 \cdot 3TEHPO$, $Th(NO_3)_4 \cdot HDPM$, $Th(NO_3)_4 \cdot 2HDPM$, $Th(NO_3)_4 \cdot EBDPM$, and $Th(NO_3)_4 \cdot 2EBDPM$. The nitrates are covalent in most of these complexes. However, the nitrates in $Th(NO_3)_4 \cdot 2HDPM$ and $Th(NO_3)_4 \cdot 2EBDPM$ appear to be partially ionic. With each ligand, the complex of higher ligand:metal ratio was the more stable one. Crystalline complexes of uranium(VI) nitrate and of thorium nitrate were prepared with EBDPM and with bis-(dicyclohexylphosphinyl)methane, CHDPM. These complexes were found to have the structures $UO_2(NO_3)_2 \cdot EBDPM$, $UO_2(NO_3)_2 \cdot CHDPM$, $2Th(NO_3)_4 \cdot 3EBDPM$, and $Th(NO_3)_4 \cdot CHDPM$. The complexes are of high thermal stability. The nitrates in all of these crystalline complexes are covalent. The proton magnetic resonance spectra of $UO_2(NO_3)_2 \cdot EBDPM$ indicates that, at least in this case, the ligand, EBDPM, is bidenate. (auth)

4245 (JAERI-1062) DATA ON INORGANIC SOLVENT EXTRACTION. [PART] 2. Tomitaro Ishimori, Eiko Akatsu, Wen-pin Cheng, Kuniko Tsukuechi, and Tomiko Osakabe (Japan Atomic Energy Research Inst., Tokyo). Feb. 1964. 32p. Dep.(mn).

Solvent extraction behavior of more than sixty elements was studied in the following systems: 5% triisoöctylamine (TIOA)–xylene–H_2SO_4; 0.1% TIOA–xylene–H_2SO_4; 10% Amberlite LA-1–xylene–H_2SO_4; 0.1% Amberlite LA-1–xylene–H_2SO_4; 10% Primene JM-T–xylene–H_2SO_4; 0.1% Primene JM-T–xylene–H_2SO_4; TIOA–xylene–0.1N H_2SO_4; Amberlite LA-1–xylene–0.1N H_2SO_4; and Primene JM-T–xylene–0.1N H_2SO_4. The results obtained are arranged according to the sequence of the periodic system. The alkali and alkaline earth metal ions are not extractable. The trivalent ions are generally extractable into Primene JM-T, but not into Amberlite LA-1 and TIOA. In most cases, the actinide elements are highly extracted with the high molecular alkylamines used. The extractability of amines studied increases in the order tertiary < secondary < primary in a sulfuric acid system. (auth)

4246 (ORNL-3627(p.1-28)) POWER REACTOR FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

Laboratory and engineering-scale development of processes for recovering fissionable and fertile material from irradiated power reactor fuels is continuing. Emphasis during the period was placed on basic chemical studies; however, major efforts are on chemical applications, engineering development, and small-scale hot-cell testing of the more promising fuel-recovery processes. Work on carbide and graphite-type fuels included basic studies on the chemical properties of U monocarbide and sesquicarbide, and development of three potential aqueous processes for U and U–Pu carbide fuels. The dissolution-rate studies on UO_2–PuO_2 and PuO_2 were extended to determine the total dissolution time. Similar studies were started on the dissolution of ThO_2–UO_2 prepared by the sol-gel process. Dissolution was slower than for pelletized fuel, but irradiated specimens of both types of ThO_2–UO_2 dissolved much more rapidly than unirradiated samples. Studies on the Zirflex process included an evaluation of UO_4 precipitation for reclaiming U from declad solutions and a survey of methods of producing neutral and alkaline Zirflex wastes stabilized to keep Zr in solution. The work on the adsorption of Pa on inorganic ion exchange materials was extended to include the evaluation of zirconium phosphate, silica gel, and molecular sieves. Solvent extraction studies were made to determine the effect of fluoride, Nb, and Al on the extraction of U by tributyl phosphate (TBP) and dibutyl butyl phosphonate (DBBP). Chloride volatility studies included an evaluation of the absorption of $ZrCl_4$ and UCl_5 in boiling water and subsequent elimination of chloride with H_2O_2, chlorination of U from the ash resulting from the combustion of graphite and carbide fuels, reduction of UCl_5 to UCl_3 with CO, and the volatilization of $PuCl_4$ in a stream of Cl_2 gas. Under the mechanical processing pro-

gram, the evaluation of the 250-ton fuel shear was completed. In addition, fuel disassembly methods for second-generation fuels were studied, the safety of shearing Zircaloy-2-clad fuels was demonstrated, and batch leaching tests on stainless-steel- and Zircaloy-2-clad UO_2 and ThO_2-UO_2 were made. (auth)

4247 (ORNL-3627(p.29-72)) FLUORIDE VOLATILITY PROCESSING. (Oak Ridge National Lab., Tenn.).

Development of a molten-salt fluoride-volatility process is described which consists basically of dissolution of the metal (or oxide) by hydrofluorination in a molten salt, volatilization of U from the melt as UF_6 by contacting the salt with gaseous fluorine, and the purification of the product UF_6 from contaminants by passing the impure gas stream through beds of NaF and MgF_2 pellets. The first fuel processed at ORNL by the molten-salt fluoride-volatility process was the molten salt from the Aircraft Reactor Experiment. The next effort was the development of a process for use with alloys of Zr and highly enriched U. A few years ago, the study of the application of the process to Al–U alloy fuels began; this work was prompted by the large potential load of such fuels to be processed. In addition, some work has been done on developing processes for fuels containing zirconia-urania, thoria-urania, beryllia-urania, and stainless steel. Studies were also made aimed at the volatilization and recovery of U and Pu from low-enrichment fuels. Work on the molten-salt fluoride-volatility process for Zr–U alloy fuels is nearly complete, and its application to Al–U alloy fuels is being studied. In the future, process development efforts will emphasize the application of the molten-salt fluoride-volatility approach to low-enrichment fuels. Also, a proposal was made to install a fluidized-bed fluoride-volatility pilot plant in Building 3019, primarily for studies on stainless-steel- or zirconium-clad UO_2. (auth)

4248 (ORNL-3627(p.115-35)) TRANSURANIUM ELEMENT PROCESSING. (Oak Ridge National Lab., Tenn.).

The Transuranium Processing Plant (TRU) and the High Flux Isotope Reactor (HFIR) are being built to provide gram quantities of many of the transuranium elements and milligram quantities of some of the transcalifornium isotopes for research purposes. Long-term irradiation of a 10-kg batch of ^{239}Pu in a Savannah River production reactor produced about 400 g of ^{242}Pu and a 200-g mixture of ^{243}Am and ^{244}Cm. These materials were recovered for fabrication into target rods, after which they will be further irradiated for 12 to 18 months in the HFIR, and the transcurium elements will be recovered as products. The Cm isotopes then will be returned to the reactor for additional irradiation. Chemical processes are being developed and equipment is being designed to make target rods, dissolve and recover transuranium elements from the irradiated targets, and prepare and ship the recovered products to customers. The development of the chemical separations processes, methods for preparing actinide oxides suitable for incorporation into HFIR targets, the design and development of the equipment to do these processes, and progress in construction of the Transuranium Processing Plant are summarized. The Curium Recovery Facility (CRF) is under construction and will be used to test transuranium process chemistry at full-scale radioactivity levels, to recover multigram quantities of ^{243}Am and ^{244}Cm for incorporation into HFIR targets, and to purify gram quantities of ^{242}Cm and ^{244}Cm for use in thermoelectric converters. This facility is being installed in cells 3 and 4 of the High Level Chemical Development Facility, Building 4507. At present, the cell-3 complex is still under construction, while the cell-4 complex, which contains the solvent extraction equipment, is complete. Equipment calibration and leak testing were completed; cold runs of chemical flowsheets are being made; and necessary equipment modifications are in progress. (auth)

4249 (ORNL-3627(p.136-52)) CURIUM PROCESSING. (Oak Ridge National Lab., Tenn.).

A program was established to produce Cm heat sources for use in thermoelectric converters. Irradiated targets of $^{241}AmO_2$ in an Al matrix will be processed to separate ^{242}Cm from Al, fission products, and eventually from ^{241}Am, although the first products will contain the residual ^{241}Am as well as ^{242}Cm. A nitric acid solution of the product will be processed and fabricated into thermoelectric heat sources. A number of process methods, facilities, and source materials are used for both the Curium Program and the closely related Transuranium Element Program. The Cm Recovery Facility (CRF) was originally planned for testing transuranium element processes at high activity levels, but modifications were made to increase capacity and to improve reliability so it can also be used to isolate multigram quantities of Cm, free of fission products. A 10-g sample of ^{244}Cm for an experimental heat source will be isolated from a nitric acid concentrate containing about 100 g of ^{243}Am, 100 g of ^{244}Cm, and 10,000 curies of rare-earth fission products which Savannah River Laboratory prepared as feed material for the Transuranium Element Program. Laboratory-scale development of the chemical processes, search for alternative process methods which may be used in existing processing facilities, and design, construction, and operation of the CRF to test the processes and to isolate multigram amounts of ^{242}Cm and ^{244}Cm are reported. (auth)

4250 (ORNL-3627(p.177-208)) SEPARATIONS CHEMISTRY RESEARCH. (Oak Ridge National Lab., Tenn.).

New separations methods and reagents are being developed, particularly for use in radiochemical processing. The current emphasis is principally on solvent extraction technology. Solvents that were developed in the former ORNL raw materials program are useful and additional extractants were discovered more recently in the continuing evaluation of new reagents. In addition to solvent extraction applications, some of these reagents or analogous compounds should be useful in other separations methods, for example, in extraction chromatography and resinous ion exchange. Progress is reported in programs of descriptive chemical studies pertinent to existing and potential separations; for development of selected separations into specific complete processes; and of fundamental chemical studies to increase knowledge of the reaction mechanisms and better define their potential applications. (auth)

4251 (ORNL-3627(p.209-15)) RECOVERY OF FISSION PRODUCTS BY SOLVENT EXTRACTION. (Oak Ridge National Lab., Tenn.).

In continued studies of the phenol extraction process for recovering Cs from Purex waste, 4-sec-butyl-2-(α-methylbenzyl)phenol (BAMBP) was shown to be adequately stable toward chemical and radiative degradation under expected flowsheet conditions. Feasibility of the process was further confirmed in a bench-scale continuous demonstration run in mixer-settler equipment. Cs recovery was better than 99%. Use of synergistic reagent mixtures (e.g., BAMBP in combination with D2EHPA) was studied, but these solvents did not appear as favorable for Cs recovery as BAMBP alone. The slow extractions of rare earths with di(2-ethylhexyl)phosphoric acid (D2EHPA) from tartrate-complexed Purex waste at a pH of about 5 are due to the presence of Cr, Fe, and Al in the waste. Apparently, the aqueous phase contains unextractable metal-rare-earth-tartrate complexes which dissociate slowly to yield extractable rare-earth species. Studies of Ce oxidation, followed by extraction with D2EHPA to obtain Ce separation from other rare earths, indicated that both persulfate and ozone are suitable oxidants. A tentative process was outlined for recovering Sr from Purex waste by extracting with carboxylic acids, scrubbing with dilute HNO_3, and stripping with HNO_3. In a batch counter-current test with citrate-complexed, simulated Purex FTW solution at a pH of about 8, more than 99% of the Sr was recovered in five extraction and two scrub stages. About 70% of the rare earths was recovered with the Sr. Efficient extraction of Tc from alkaline waste supernatants was demonstrated with Aliquat 336 (a quaternary amine). However, an acceptable method for stripping the Tc from the solvent was not found. Engineering studies of a solvent extraction pro-

cess using a substituted phenol (BAMBP) for the recovery of Cs from simulated Purex-type waste were made. The flow capacity of pulsed columns for the extraction, scrub, and strip sections of the flowsheet were measured as a function of pulse conditions and flow ratio. Batch phase-separation tests were made for comparison with other known systems and to provide a basis for evaluation of mixer-settlers as contactors for this system. (auth)

4252 (ORNL-3627(p.216-19)) CHEMISTRY OF PROTACTINIUM. (Oak Ridge National Lab., Tenn.).

A major part of the year was devoted to recovering and purifying the remainder of 50 g of ^{231}Pa obtained from the British for use in preparing about 1 g of ^{232}U for cross-section measurements. Three methods were studied for separating Pa from U, Th, and Nb, the three most serious contaminants. Although all showed promise, the anion exchange procedure utilizing mixed hydrochloric-hydrofluoric acid solutions and fluoride complexing was used because of more experience with it. About 40 g of ^{231}Pa was recovered. The study of the chemistry of Pa in H_2SO_4 solutions was continued, using the solvent extraction method. The unusual dependence of the Pa distribution coefficient on Pa concentration, possibly due to polymerization of Pa was studied under a variety of conditions. At Pa concentrations that are quite low the extraction coefficient was nearly constant; but as the concentration was increased, the coefficient increased very sharply and then either leveled or slowly decreased at higher concentrations. Fluoride ion has less effect on Pa extraction from H_2SO_4 than from HCl. (auth)

4253 (ORNL-3627(p.231-2)) MECHANISMS OF SEPARATIONS PROCESSES. (Oak Ridge National Lab., Tenn.).

A program to provide quantitative descriptions of separations processes is described. Activities of water, nitric acid, and tributyl phosphate (TBP) over two- and three-component systems containing water, nitric acid, uranyl nitrate, and TBP are being measured in order to express solvent extraction data for these systems in terms of mathematical equations. The transpiration method for the dynamic measurement of vapor pressure was used to obtain the partial pressures of water and nitric acid over the system $-H_2O-UO_2(NO_3)_2 \cdot 6H_2O-HNO_3$. These results were combined with literature data on the activities of water and nitric acid over the systems $-H_2O-UO_2(NO_3)_2 \cdot 6H_2O$ and H_2O-HNO_3- to obtain appropriate relations for calculation of the activities of $UO_2(NO_3)_2 \cdot 6H_2O$ after an integration of the Gibbs-Duhem equation. The activities of water and TBP were measured over the system $-H_2O-UO_2(NO_3)_2 \cdot 6H_2O-TBP-$ and the data were fitted to an empirical equation. Partition data for this system were fitted to an equation with the same independent variable. The solution of these two simultaneous linear equations expresses the activity coefficient of TBP as a function of the concentration of U in the organic phase. (auth)

4254 (ORNL-3627(p.235-46)) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

The work reported for this year includes: definitive studies on design parameters for a high-performance solvent extraction contactor which uses liquid cyclones for stages; the quantitative verification of the effect of ionizing radiation on coalescence in liquid-liquid systems and attempts to formulate an explanation for it; progress in attempts to use light scattering as a method for particle-size analysis in radioactive gas streams; an unsuccessful attempt to use magnetically induced current for the electrolytic dissolution of stainless steel fuel elements; and progress in an attempt to develop a model of the transient behavior in gas-absorption towers. (auth)

4255 (ORNL-3627(p.267-8)) CHEMICAL PROCESSING FOR THE MOLTEN-SALT REACTOR EXPERIMENT. (Oak Ridge National Lab., Tenn.).

The Molten-Salt Reactor Experiment is a 10-Mw single-region reactor using an $LiF-BeF_2-ZrF_4-UF_4$ (65-29-5-1 mole %) fuel salt at 1200°F. The reactor is nearing completion and a chemical plant was designed for installation in the same building in a cell adjacent to the drain cell. The chemical plant was designed to remove oxides (in fuel salt as ZrO_2), which might eventually cause U precipitation; and to recover U from spent fuel or contaminated flush salt. Equipment for this plant is being built. (auth)

4256 (ORNL-TM-886) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, APRIL 1964. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 72p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Work on the sorption of water and CO_2 from streams of He is the basis for a design technique using a computer calculation of a mathematical model for deep beds. The model is based on a sorption mechanism of intracrystalline diffusion found in differential bed studies and validated by tests. In fission product recovery research, pulsed column flooding velocities for extraction, scrubbing, and stripping were run on a proposed flowsheet for the extraction of fission-product Cs from waste solutions with a substituted phenol (BAMBP). In fluoride volatility research, the previous work on the mechanism of UF_6 sorption on NaF pellets was incorporated into differential equations for predicting the performance of deep packed beds. Experimental data from runs with such beds will be compared with computer calculations. The design of an induction furnace for testing large-diameter calciners is described. (auth)

4257 (UJV-1106/64) K PROBLEMATIKE PRIRODNYKH SORBENTOV V KHSSR I IKH PRIMENENIYA DLYA DEKONTAMINATSII OTBROSHYKH RADIOAKTIVNYKH VOD. (On the Problems of Natural Sorbents in Czech SSR and on the Applications of the Sorbents for Decontamination of Radioactive Liquid Waste). L. Berak and Z. Dlougi (Československá Akademie Věd. Ústav Jaderného Výzkumu, Řež). [1964]. 13p. Dep.(mn).

Aluminosilicates, such as bentonite and vermiculite, must possess high selectivity and high sorptive capacity, in order to qualify as a natural decontaminating agent for radioactive waste liquors. Therefore, a number of naturally available materials were tested as to their selective sorption with respect to ^{137}Cs and ^{90}Sr. It was found that rhyodacite tuff from the Lower Grabowitz district possesses excellent sorption properties. The pumice rhyolite specimens had a simple structure and without exhibiting any capillarity, were able to separate the radioactive contamination from waste liquors containing large amounts of dissolved salts. Its sorptive capacity, as expressed by its separation factor, varies between 5×10^4 to 1.4×10^5 ml/g. In actual use, the flow rate of the liquid through the absorption column, the length of the column and the concentration of the inactive ions in the liquid must be taken into account when designing a decontamination system. (TTT)

4258 (AEC-tr-6227/2(p.73-86)) SEPARATION OF PLUTONIUM FROM URANIUM AND FISSION PRODUCTS ON ZIRCONIUM PYROPHOSPHATE. D. Cvjeticanin and N. Milic. Translated from Bull. Boris Kidrich Inst. Nucl. Sci., 15: No. 2, 73-86(1964).

The distribution coefficients of Pu^{3+}, Pu^{4+}, PuO_2^{2+}, UO_2^{2+}, $^{234}Th^{4+}$, ^{95}Zr, ^{95}Nb, ^{106}Ru, $^{144}Ce^{3+}$, $^{90}Sr^{2+}$, $^{137}Cs^{+}$, $^{59}Fe^{3+}$, and $^{59}Fe^{2+}$ were determined in the system zirconium pyrophosphate-aqueous solution of HNO_3. From the distribution coefficients it may be concluded that some separations among the cations are possible. This has been confirmed by investigations on columns. The following separations proved possible: $^{90}Sr^{2+}$ from $^{90}Y^{3+}$; $^{90}Sr^{2+}$ from $^{90}Y^{3+}$ and $^{137}Cs^{+}$; UO_2^{2+} from $^{234}Th^{4+}$; Pu^{4+} from UO_2^{2+}, ^{95}Zr, ^{95}Nb, ^{106}Ru, $^{144}Ce^{3+}$, $^{90}Sr^{2+}$, and $^{137}Cs^{+}$. Decontamination factors of plutonium from the above cations were determined. It has been confirmed that the sorption of Cs^{+} and Sr^{2+} is based on ion exchange. (auth)

4259 THE INFLUENCE OF MASS-EXCHANGE RATE ON THE INDICES IN AUTOCLAVE URANIUM LEACHING PROCESS. B. V. Nevskii, I. P. Smirnov, and S. A. Pirkovskii. At. Energ. (USSR), 17: 201-5(Sept. 1964). (In Russian)

Experimental results are given that show the effects of

pulp density, construction, and operating range of a mixing apparatus on mass exchange, sulfide oxidation, and uranium mineral dissolution in a 0.5-m^3 autoclave. Four types of mixing apparatus were tested for optimum pulp density. The mixer providing the best indices of the process was chosen. After leaching the uranium ore for 2 hr under optimum conditions 80% of the sulfide was oxidized and 70 to 74% of the uranium was dissolved. (tr-auth)

4260 OXIDATION-REDUCTION POTENTIAL AND THE DEGREE OF URANIUM LEACHING IN SULFURIC ACID SOLUTIONS. A. P. Filippov and E. A. Kanevskii. At. Energ. (USSR), 17: 205-8(Sept. 1964). (In Russian)

Some regularities in the oxidation of UO_2 by manganese dioxide in sulfuric acid solutions were studied in the absence and during the introduction of iron ions. It was shown that the value of the oxidation-reduction potential indicates only the potential possibility of the system and can not serve as an unambiguous criterion of the intensity of oxidation of UO_2; the true rate of the process is determined by the reaction mechanism. A study was made of the dependence of the degree of oxidation and dissolution of UO_2 at 20 and 85°C in a sulfuric acid solution on the values of the oxidation-reduction potential with introduction of MnO_2 and Fe(II). This dependence is expressed by S-shaped curves. The catalizing role of iron ions in the oxidation reaction of UO_2 with MnO_2 in sulfuric acid solution was demonstrated. (tr-auth)

4261 PILOT PLANT FOR TREATMENT OF URANIUM ORE. Bol. Junta Control Energia At. (Peru), 9: No. 48, 119-24(Jan.-Mar. 1964). (In Spanish)

A pilot plant for the treatment of uranium ore consists of six sections: dry sorting, wet milling, leaching, precipitation, carbonation, and vanadium extraction. Each section is briefly described. (J.S.R.)

4262 EXTRACTION OF HEXAVALENT URANIUM BY TRILAURYLAMINE NITRATE. P. J. Lloyd and E. A. Mason (Massachusetts Inst. of Tech., Cambridge). J. Phys. Chem., 68: 3120-9(Nov. 1964).

The effects of amine, uranium, and hydrogen ion concentrations on the extraction of U(VI) from acidic nitrate solutions by tridodecylamine nitrate in toluene were studied at constant nitrate concentration. Over a wide range of these variables, it was found that the data could be correlated quantitatively on a basis of a mechanism of extraction involving equilibria between amine nitrate monomer and dimer species, extraction of uranium by both of these species, and extraction of nitric acid by the amine nitrate. By determination of the nitric acid extracted into the organic phase by the fourth equilibrium, it was possible to calculate the concentration of amine nitrate available for participation in the other equilibria. From a reported value of $K = 110 \pm 30.1$ $mole^{-1}$ for the first equilibrium, values of $K_I = 50 \pm 10$ l^2 $mole^{-2}$ and $K_{II} = 200 \pm 50$ l^2 $mole^{-2}$ were estimated for the equilibria involving uranium extraction by amine nitrate monomers and dimers, respectively. Data are also presented on the variation of nitrate and hydrogen ions in the organic phase with uranium loading, from which it was concluded that no species other than the uranyl nitrato complexes are extracted. The difficulties caused by amine nitrate aggregation during studies on the mechanism of extraction of metals by other amines in other diluents are discussed. (auth)

4263 SEPARATIONS USING SOLVENT EXTRACTION. H. Green. Metallurgia, 70: 201-4(Oct. 1964).

Selected procedures for the solvent extraction of 10 elements are described. The elements include: Al, Sb, As, Be, Bi, B, Cd, Ca, Ce, and Cr. 70 references are included. (P.C.H.)

4264 MANUFACTURE OF URANIUM FLUORIDE. Maurice Delange, Henri Huet, and Paul Vertes (Commissariat à l'Énergie Atomique). British Patent 970,994. Sept. 23, 1964. Priority date Apr. 20, 1960, France.

A process and apparatus for continuous production of UF_4 is described. UO_2 granules are fed into the top of a furnace countercurrent to a HF stream. The residual gas is absorbed by the UO_2 granules in the feed conduit. (T.R.H.)

4265 METHOD OF PURIFYING URANIUM METAL. Robert J. Teitel and Gilbert S. Layne (to Dow Chemical Co.). U. S. Patent 3,148,977. Sept. 15, 1964. Filed Dec. 11, 1961.

A method of purifying uranium metal without taking up the uranium into the purifying agent or medium is described. The uranium metal is intimately contacted with at least an equal weight of a molten Mg–Cu alloy for at least one hour. The alloy consists of at least 30 wt %.Mg, 20 wt % Cu, and not more than 10 wt % of other metals. (M.C.G.)

4266 PREVENTION OF INSOLUBLE MOLYBDENUM-AMINE COMPLEXES IN THE LIQUID-LIQUID EXTRACTION OF URANIUM USING AMINE EXTRACTANTS. James L. Drobnick and Clifford J. Lewis (to General Mills, Inc.). U. S. Patent 3,156,524. Nov. 10, 1964. Filed Sept. 22, 1958.

An improvement in the amine extraction of U from leach liquors is offered which eliminates the amine-Mo complex interfering with the process. The addition of H_2O_2 to the extract prior to U stripping maintains the Mo in molybdate form and preventing Mo complex precipitation. (T.R.H.)

4267 PROCESS FOR SEPARATING URANIUM AND VANADIUM VALUES. Angus V. Hendrickson (to Kerr-McGee Oil Industries, Inc.). U. S. Patent 3,157,462. Nov. 17, 1964. Filed Aug. 9, 1960.

An anion exchange process for separating V from ore liquors or pulps is described. In one example, a V solution, 0.2 g/l of V_2O_5 was adjusted to pH 9.9 and stirred with IRA-400 resin. The V adsorbed amounted to 17 mg V_2O_5 per g of resin. The U present as uranyl tricarbonate complex in other examples is not adsorbed. (T.R.H.)

ENGINEERING

General

4268 (COO-623-102) ANALYSIS OF AN INTERFERENCE TECHNIQUE FOR THIN FILM STRESS MEASUREMENT (thesis). Technical Report No. 34. Tatuichiro Nishiyama (Case Inst. of Tech., Cleveland). June 1964. Contract AT(11-1)-623. 51p. Dep.(mn); $3.00(cy), 1(mn) OTS.

The iron films, 425, 509, and 525 Å in thickness were evaporated on a thin glass substrate at an angle of 36.5° by vacuum deposition at a pressure of 10^{-7} mm Hg. The intrinsic stress in the film was measured by using interference techniques. The presence of the sharp peak of the stress at a film thickness of about 700 Å was not confirmed by this experiment since the films were all less than 600 Å thick, while the thickness dependence and anisotropy of the stress were observed. It was also worth noting that the stress behavior of films deposited on the concave side of the substrate seemed to be different from that on the convex side of the same substrate. Detailed studies were carried out to estimate the accuracy of this measurement. Firstly, error due to tilt of the substrate to the observing coordinate system by the presence of dust between the substrate to be measured and an optical flat was considered. As a result of this investigation, it was estimated that the actual contribution of dust to accuracy might be negligible under usual circumstances. Secondly, an attempt was made on the statistical estimation of overall error for this measurement with the aid of the concepts of 90 percent confidence interval for population means. (auth)

4269 (GEMP-288) PLANE-STRAIN PLASTIC-VISCOELASTIC DEFORMATION OF A COMPOSITE TUBE. J. P. Yalch (General Electric Co. Advanced Technology Services, Cincinnati). May 1964. Contract AT(40-1)-2847. 62p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A method and an associated computer program are described for calculating during successive time intervals the plastic stress/strain distribution in a long hollow circular composite cylinder subjected to an internal pressure and axial load and having a variable axisymmetric temperature distribution. The computer program (NMPO No. 748) was coded in the FORTRAN II language for the IBM 7090/4 machines. (auth)

4270 (HW-SA-3512) WATER-HAMMER IN A COMPLEX PIPING SYSTEM. COMPARISON OF THEORY AND EXPERIMENT. Stephen S. Jones (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1, 1964. Contract AT(45-1)-1350. 40p. (CONF-763-2). Dep.(mn); $2.00(cy), 1(mn) OTS.

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A water-hammer model is developed for a complex piping system that extends from four pumping stations to two reservoirs and several nuclear reactors. Using this model the Bergeron graphical analysis procedure is applied to determine the pressure and flow transients incident to the sudden loss of pumping, sudden pump startup, and other water-hammer conditions. The results of these theoretical analyses are compared with experimental water-hammer tests conducted on this complex piping system. (auth)

4271 (IS-816) MOMENTUM TRANSPORT IN PACKED COLUMNS USING STOCHASTIC MODELS. Charles B. Schriver and Raymond W. Fahien (Ames Lab., Ames, Iowa). Nov. 1963. Contract W-7405-eng-82. 153p. Dep.; $5.00 (cy), 3(mn) OTS.

The mean momentum loss and the variation in momentum loss for a group of packed beds having a similar structure were studied using a stochastic approach. In this approach, the packed bed is considered as being composed of layers of independent momentum sinks called momentum cells. Each momentum cell consists of a piece of packing and the associated fluid surrounding it. The boundary of the cell is the locus of the points of maximum velocity between pieces of packing. This boundary is, by assumption, equidistant from the surrounding packing surfaces. A momentum balance over a typical cell yields an expression for momentum loss that is similar to the Hagen-Poiseuille equation except that the derived equation is more applicable to porous media and correctly predicts that the laminar constant will increase with increasing porosity. This concept of a momentum cell allows such defined properties as porosity and hydraulic radius to be calculated for each cell. The momentum cell properties used in this study were calculated from measurements made on experimental packed beds constructed of wax and cork. The packings studied were spheres, cylinders, and Raschig rings. The effect of column to particle diameter and the method of packing were also studied. These experimental beds were sectioned and photographs of the sections were taken to provide information on the internal structure of the beds. In particular, the variation of porosity with radial position and the distribution of packing within the bed were studied. These photographs and measurements emphasize the importance of the region near the wall and how the flow is channeled in this region. The calculated momentum cell properties are presented in the form of frequency distributions or histograms. In the actual calculations, the model was divided into two regions, a core region and a wall region, with each region having its own distribution of cell properties. The velocity of the fluid in each cell in a given layer was calculated by minimizing the energy loss for the layer of cells. This criterion of flow distribution was found to be equivalent to assuming equal momentum loss for each cell in a given layer. Using a digital computer, the above model of a packed bed and the measured momentum cell properties were used to predict the mean momentum loss and the variance in momentum loss for a group of packed beds having the same superficial bed properties. It was found that the variation in momentum loss for such a group of beds could amount to as much as 20 percent of the mean momentum loss for beds having a small volume. These results are compared with those of other investigators. (auth)

4272 (NAA-SR-4527) ANALYSIS OF STRESSES IN BELLOWS. PART I. DESIGN CRITERIA AND TEST RESULTS. W. F. Anderson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. 96p. Dep.; $3.00(cy), 2(mn) OTS.

Design charts and systematic design forms are presented for simplified calculations to check the number of convolutions and thickness required to limit the deflection and pressure stress range in three types of bellows: (1) convoluted bellows, (2) convoluted bellows with reinforcing rings, and (3) toroidal bellows. The design charts are based on the equations for stresses derived from an asymptotic solution for the equations of toroidal shells. Proposed stress limitations to be used with the calculated stresses are based on those of the ASA Code for Pressure Piping. Data from 108 fatigue tests at 70°F and 18 fatigue tests at 1200°F for all three types of bellows are presented. These data are evaluated statistically and justify use of the proposed allowable stresses. The conclusion is drawn that expansion joint bellows can be designed to the same stress levels as other components of a piping system with equal confidence in the reliability of the design. (auth)

4273 (NAA-SR-Memo-10250) OPERATING REQUIREMENTS FOR SCTI 35-MW SODIUM HEATER IN THE EVENT OF SODIUM LEAK. R. Cygan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 23, 1964. Contract AT-11-1-GEN-8. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The heat energy stored in the refractory lining of the

35 Mw sodium heater is about 29×10^6 Btu. Most of this heat ($\sim 26 \times 10^6$ Btu) is stored in the brickwork surrounding the radiant section of the heater. Because the radiant section contains only a small portion of the total tubing in the heater and concomitantly a low sodium inventory, the radiant section requires supplementary cooling to remove the heat from the firebrick until the latter is brought to a temperature about 1600°F. Based on the analysis, draining the heater tubes before the brickwork has cooled down is not feasible because the empty metal tubes do not have adequate heat capacity to absorb the residual heat before reaching excessive metal temperatures. The forced draft fan should be operated until such time as the tube temperatures in the radiant section have passed their peak and have started decreasing. Because the heat release rate is limited by the conductivity of the firebrick, this may take about one hour. Although rapid heat removal can be achieved by maintaining sodium circulation, it is not advisable since the leak rate is more than doubled when sodium circulation is maintained and the air flow supplied by the fan is capable of removing the heat released by the refractory. Complete furnace cooling (to 1600°F) will take 4 or 5 hours. Sodium leakage rates for various sizes of postulated hole sizes have been calculated. The range of leakage rates found was from 340 to 0.3 gpm, which cover holes from 1.06 to 0.0625 inch diameter. The time to drain the heater with gravity drainage has been calculated as 21 minutes. (auth)

4274 (NP-14446) PRESSURE REGULATORS FOR AIR PULSATION. A. Hall, J. Perez-Sanchez, G. F. Lazzaretto, and A. Redon (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Mar. 1963. 66p. (ETR-161). Dep.(mn); $3.00(cy), 2(mn) OTS.

Three pressure regulators, namely the Airpack, the Airdron, and the Nullmatic 40, usually used for supplying the air in air control systems, have been widely tested in pulsation service. Results presented cover two groups of experiments and give extensive data on behavior, range, and stability of the regulators. Comparative tables and diagrams are also included. It has been found that the pulse amplitude is not dependent on the type of pressure regulator; and it is stressed that only the Nullmatic 40—air supplied at high pressure—could fulfill the requirements of columns, like the C2, having a large air consumption. (auth)

4275 (RFP-432) INTRODUCTION TO TOLERANCE CHARTS—AN ELEMENTARY TREATMENT OF THEIR FORMATION AND USE. Frank Van Dok (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Nov. 1964. Contract AT(29-1)-1106. 75p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The compilation and use of tolerance charts in manufacturing process control are discussed. The report was written as a teaching tool for industrial engineering.(R.E.U.)

4276 INTERLABORATORY COMPARISONS OF ELECTRICAL QUANTITIES. R. E. McCallum (Sandia Corp., Albuquerque, N. Mex.). 18p. (CONF-701-11; SCDC-64-1532)

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

Problems involved in making comparative measurements of electrical quantities by different laboratories are presented. Comparisons between laboratories operating at comparable accuracy levels in different agencies, as well as between laboratories operating at different accuracy levels within the same agency, are discussed. Considerations involved in deciding whether agreement obtained is adequate for the needs involved are enumerated. (auth)

Applications of Nuclear Explosions

4277 (UCRL-7350(Rev.1)) CHARACTERISTIC EFFECTS OF CONTAINED NUCLEAR EXPLOSIONS FOR EVALUATION OF MINING APPLICATIONS. Charles R. Boardman, David D. Rabb, and Richard D. McArthur (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 12, 1963. Contract W-7405-eng-48. 46p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Recent underground nuclear tests in tuff, alluvium, salt, and granite have yielded data essential to the evaluation of mining applications of contained nuclear detonations. The data indicate that for these media the cavity radius is predictable within ±20% without regard to the properties of the rock in the immediate shot environment. Properties of the chimney of broken rock resulting from collapse of the cavity, on the other hand, are found to be related to the properties of the rock and its preshot structural weaknesses. Seismic effects and radioactivity distribution are sufficiently documented to serve as a basis for predicting the safety conditions associated with detonations for a variety of yields. (auth)

4278 EXCAVATING WITH NUCLEAR EXPLOSIVES. Gerald W. Johnson. Discovery, 25: No. II, 16-21 (Nov. 1964).

The theory of cratering, the mechanics of explosions, cost, and safety for excavating with nuclear explosives are discussed. The possibility of a new "Panama Canal" using nuclear explosives is considered. (C.E.S.)

Facilities and Equipment

4279 (IS-991) DESIGN AND OPERATION OF A FLAT LINEAR INDUCTION PUMP. Delwyn Donald Bluhm, R. W. Fisher, and J. W. Nilsson (Ames Lab., Ames, Iowa). July 1964. Contract W-7405-eng-82. 74p. Dep.; $3.00(cy), 2(mn) OTS.

A five-pole, one slot per phase, full pitch, twelve coil, wye connected, three-phase linear induction pump has been designed for operation with 400°C sodium. The design incorporated a graded winding in order to reduce the net pulsating component of the magnetic flux density wave and a pump duct using copper side bars. The small laboratory-size pump was designed in two steps: stator design and winding design. First, the stator and core dimensions were established on the basis of maximum pressure development and maximum power at the design flow and slip. Maximum pressure output was a requirement of the intended pump application. The condition of maximum power output was used in order to provide a good pump efficiency. Second, the parameters for the induction pump equivalent circuit were determined for several winding methods. The winding method which offered 3920 ampere turns per phase (equivalent to a flow rate of 4.88 gpm, a pressure of 60 psi, a line voltage of 250 volts, and a wave length of 21.2 cm as calculated in the first step) was selected. The theoretical performance characteristics of the flat induction pump were computed using the equivalent circuit parameters for a winding with 60 turns per coil. The measurement of developed pressure (0 to 42.13 psi), sodium flow rate (0 to 9.93 gpm), and power input (0 to 103.9 watts) after installation of the pump in an operational sodium circulating loop provided an experimental determination of the pump performance characteristic. In addition, the effect of pump duct temperature on sodium flow rate and a differential transformer system used to locate the sodium level in manometer columns were briefly discussed. (auth)

4280 (NAA-SR-Memo-9438) ENVIRONMENTAL LABORATORY AND EQUIPMENT. W. E. Gauvain (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 9, 1964. Contract AT-11-1-GEN-8. 72p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A description of the Atomics International Environmental Laboratory, its test equipment, and the testing techniques used there is presented. Particular emphasis is given to vibration, shock, acceleration and static testing, and to the unique test methods developed by the laboratory staff. (auth)

4281 (NYO-2682-1) HIGH PRESSURE PUMP SEAL DEVELOPMENT. Final Report. J. G. Williams and R. C. Hajner (Worthington Corp. Advance Products Div., Har-

rison, N. J.). Aug. 1, 1964. Contract AT(30-1)-2682. 220p. Dep.(mn); $6.00(cy), 4(mn) OTS.

A controlled leakage type seal concept has been investigated as applied to large high-pressure sealed circulating pumps. Problems associated with the application were studied to optimize a seal system integrated with a specific large size pump. Consideration was given to the design of component pump parts affecting the seal operation, and to the problem of heat removal between the pump and seal chamber. The seal concept was first reduced to a working design by means of tests performed on a model seal ($1\frac{3}{4}$ shaft size). Model seal performance was established over a range of conditions which would equal or exceed those anticipated in the final seal size. The model seal operated successfully at film thicknesses ranging from 50 to 200 microinches, between sealing pressures of 1,000 to 4,000 psi, and shaft speeds from 900 to 3600 rpm. The overall hydraulic characteristics and performance of the large $5\frac{1}{2}$ inch diameter shaft seal and model seal were comparable. It was evident that the same variables control the performance of both seals. However, the influence of physical size caused certain variables to change from a status of minor importance to one which could strongly influence the performance of the seal. Tests of the large seal showed that existing manufacturing flatness tolerance stack-ups and sheer physical bulk of the seal components developed into factors of critical importance in terms of minimum permissible leakage rate. Simultaneous evaluation of two large seals mounted back to back on a common shaft introduced certain peculiar variables which appear to be associated with the configuration of seals and bearings in this facility. In the model seal test facility, which closely simulates the arrangement of a seal and thrust bearing as in a pump, none of these peculiar variables could be detected. Two endurance runs of 250 hours each showed satisfactory performance for leakages of about 30 gph at pressures of 2200 psi and shaft speeds of 600 rpm. Unstable seal operation at large film thicknesses which was observed on both the model and large size seals, was characterized by large seal control pressure fluctuations and audible noise. This phenomenon was not thoroughly investigated although the characteristics are suggestive of hydraulic phenomena associated with Reynolds Number, hydraulic spring rate, or combinations of both. Hot stand-by tests of the integral seal cooling system showed that the temperature of the water at 2000 psi was reduced from 625°F to about 100°F before passing through the seal at a rate of 15 gph. (auth)

4282 (RFP-435) GASKET FAILURES IN PLUTONIUM REDUCTION FURNACES. W. V. Conner (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Oct. 28, 1964. Contract AT(29-1)-1106. 33p. Dep.; $2.00(cy), 1(mn) OTS.

Occasionally, the gasket between the pressure vessel and block valve fails, resulting in ejection of slag from the vessel. A study was made of the cause of the gasket failures. A mechanism of these failures is proposed in which the molten material, formed by the reaction of the reduction charge, is splattered onto the gasket and dissolves a portion of it. (D.L.C.)

4283 (UCRL-13129) FINAL REPORT FOR AN ATMOSPHERIC SAMPLING SYSTEM. (Ryan Aeronautical Co., Lindbergh Field, San Diego, Calif.). Aug. 27, 1964. Contract W-7405-eng-48. 148p. Dep.(mn); $4.00(cy), 3(mn) OTS.

The concept of an unmanned drone for sampling nuclear detonation debris from nuclear clouds is described. The drone will be operated remotely with the aid of telemetry data from the drone. A two-phase program for the development of the drone is being planned in which prototype and operational vehicles will be constructed. (D.L.C.)

4284 (Y-1471) STRAIN GAGE TEST AT THE THREADED CLOSURE ON A THIRTY-INCH PRESSURE VESSEL. P. J. Long and W. D. Ross (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). Aug. 10, 1964. Contract W-7405-eng-26. 33p. Dep.; $2.00(cy), 1(mn) OTS.

A study has been made utilizing the strain-gage measurement method to determine the stresses experienced by the internal threaded areas of the closure on a 30-inch pressure vessel at the Y-12 Plant. This test was performed to gain information that can be used for: (1) determining the maximum stress levels at operational pressures, (2) estimating the useful operational life of the vessel at various stress levels, (3) making a comparison with photoelastic studies that were obtained on models of a vessel of very similar design, and (4) estimating the operational pressure parameters of the proposed alterations to the vessel. Measurements were obtained by utilizing metal-film gages having a gage length of 0.050 inch and a width of 0.044 inch. These gages were secured in the root of the threads with Eastman 910 cement. Measuring accessibility was attained using enameled wire of Size 34 AWG, spot cemented into the root of the thread. Conventional strain readout instrumentation was used. The highest strains measured were obtained in the thread closest to the internal pressurized area. These values were approximately 3470 microinches/inch. Results of the test indicate that reliable information can be obtained by this strain-measuring technique provided the installation of the gages and lead wires is given close attention. (auth)

4285 (Y-KE-162) NUMERICALLY CONTROLLED INSPECTION MACHINES. Paper No. CP-64-566. T. E. Douglass (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). [Sept. 1964]. Contract [W-7405-eng-26]. 14p. (CONF-802-1) Dep.(mn); $1.00(cy), 1(mn) OTS.

From Machine Tool Builders Conference, Hartford, Conn., Nov. 1964.

Productivity, precision of operation, and costs of numerically controlled inspection machines at Y-12 are discussed. The eleven machines are of four types: Y-Z, vertical jig-borer, IR/OR sweep gages, and commercial measuring machines. (R.E.U.)

4286 EVAPORATORS FOR THE DECONTAMINATION OF EFFLUENT WATER. H. Mende. Atomwirtschaft, 9: 498-504(Oct. 1964). (In German)

The decontamination of radioactive polluted water by distillation is discussed. Special consideration is given to the evaporator used. The purchase price and operating costs of the evaporation plant must stand in a favorable relationship if the decontamination is to be economic. The required heating surface is an important parameter influencing these costs. In this connection the type of evaporator has an essential influence on the price of the distillate. The individual types as well as the energy consumption of single and multi-stage evaporators are compared. A cost comparison showed that in the case of continuous operation a directly heated evaporator shows the highest distillate price, an evaporator with vapor jet compression of the steam a considerably lower price, and a forced circulation evaporator with a electrically driven compressor by far the lowest price. This applies for equal capacities, equal heating costs, and favorable operating conditions. (P.C.H.)

4287 A SPINNING DISC AEROSOL GENERATOR. L. C. Schwendiman, A. K. Postma, and L. F. Coleman (General Electric Co., Richland, Wash.). Health Phys., 10: 947-53(Dec. 1964). (HW-SA-3335)

A spinning-disk aerosol generator for producing narrow size-range particles is described and its operating parameters discussed. Methylene blue-uranin, rhodamine B, lead nitrate, and sodium chloride were used to produce soluble aerosols, however; other materials and techniques are suggested for preparing insoluble particles in the 2- to 10-μ size range. The instrument has proven useful in studies involving the transport and deposition of particles. An example of the application is shown, that of measuring particle deposition in elbows formed in aluminum tubing. (P.C.H.)

4288 A CANINE INHALATION EXPOSURE APPARATUS UTILIZING A WHOLE BODY PLETHYSMOGRAPH. B. B. Boecker, F. L. Aguilar, and T. T. Mercer (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Health Phys., 10: 1077-89(Dec. 1964).

A canine inhalation exposure apparatus that incorporates a whole-body plethysmograph with the normal dry box arrangement was constructed. The dog's respiration causes air to move in and out of the plethysmograph through a pneumotachograph producing a signal proportional to respiratory flow rate which, when integrated, also yields tidal volume information. The main advantage of this system is that respiratory measurements can be made during exposure without encumbering the nose with a respiratory mask and valving arrangement. The aerosol is continuously produced, drawn past the dog's nose and collected in overflow filters during exposure. In this manner, the dog is exposed to fresh aerosol with each inspiration and the mean aerosol concentration during exposure can be obtained by determining the amount of radioactivity in the dog and the overflow filters after the exposure. (auth)

4289 ELECTROMAGNETIC PUMP FOR LIQUID METALS. R. S. Baker. Mech. Eng., 86: 54-6(July 1964).

An electromagnetic pump for liquid metals is described. Features of the pump are large capacity, few moving parts, fluid rate control and braking ability, variety of construction materials, and its ability to handle any metal. Operational details of the pump are included. Pumping data for liquid sodium are presented and its possible use for nuclear reactors considered. (Rev. Metal Lit., 21: No. 11, Nov. 1964)

4290 REMOTE WELDING DEVICE (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1141)

This remotely operated, helliarc welder is used in seal welding of capsules located in hot cells. It is enclosed in a plexiglas cage that contains the required inert atmosphere. The torch is remotely positioned vertically or horizontally. The capsule revolves on a water-cooled turntable that is operated by a Selzen motor system. (F.S.)

4291 TURBINE SPEED MEASURING SYSTEM /Q-2124/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1143)

This package contains 2 drawings. For a listing of individual titles see the Engineering Materials List (TID-4100). This speed measuring system is used to measure the velocity of a high-temperature turbopump. It consists of a pick-up assembly, hi-pass filter, 10-w audio amplifier, 2 alarms for underspeed, an alarm for overspeed, an overspeed scram switch, an external meter, and a Brown recorder. The pick-up consists of 2 magnets, 2 pole pieces, 2 heat dissipators, and assorted hardware. Accurate speed measurements are possible in the range of 0 to 24,000 rpm. (F.S.)

4292 DELTA P MANOMETER LEVEL ELEMENT /Q-2122/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1144)

This package contains 1 drawing. For a listing of individual titles see the Engineering Materials List (TID-4100). This instrument is used to continuously measure the level of potassium in an expansion tank or catch tank at temperatures up to 1500°F. It also may be used to measure the level of any liquid metal. (F.S.)

4293 ELECTRON BEAM WELDER (Engineering Materials). (California. Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1155)

The electron beam welder is constructed of No. 303 nonmagnetic stainless steel. It comprises an anode, cathode, gun body, and insulator. The following electronic components are used: 0.7 Farad capacitor, rectifiers, transformers, unregulated 0 kv to 35 kv 10 ma power supply, line scaler, pulse amplifier, pulse generator, and a filament gate. The pulse amplifier utilizes direct cathode coupling and biasing to avoid pulse limitation by coupling components. Its input is 105 to 125 v, 60 cps, and its output is 0 to 20 pps, 2 μsec to 2 ms (determined by input)—30,000 v at 2a maximum to the external load. Its rise time is 0.5 μsec and it is independent of pulse width. The chassis is built with solid sides. It has a 14 in. front panel 20 in. deep and weighs 115 lb. The high power pulse generator utilizes a start-stop pulse generation principle and has d-c coupling throughout the pulse amplifier system so that pulse width is not limited by coupling components. Its input is 105 to 125 v, 60 cps, and its output, with the timing device, is 3 to 60 pps, 0.2-2 msec adjustable width. The unit is built on a standard, rack mounted chassis with a 10 to ½ in. front panel. It is 20 in. deep and weighs 61 lb. The filament gate provides pulsating 60 pps power to the gun filament to minimize filament current interference with the beam. The input is 0.6 v a-c and its output is 0 to 16 v peak pulsing d-c. The electron drilling and welding tool uses a relatively low pulsed beam voltage of 25 kv or less, contamination free cathode, requiring no focusing magnets; and it produces sharp beam focusing that permits precision machining of large pieces. It produces clean, tight welds and is used in soldering. Copper has exhibited a detrimental effect on this type of oxide gun. Thirty-six drawings are included. (F.S.)

4294 IMPROVEMENTS IN OR RELATING TO COUPLING MECHANISMS. (to General Dynamics Corp.). British Patent 965,344. July 29, 1964. Priority date Nov. 8, 1961, United States.

A coupling mechanism for a control rod in a reactor is designed which may be rapidly connected and disconnected. The mechanism comprises a pair of coupling elements, one of which is secured to the control rod and the other to the lower end of the elongated lifting member; a linking member secured to one of the coupling elements for movement into engagement with the other coupling element; and disengaging means. (D.L.C.)

4295 REMOTE CONTROL MANIPULATOR. Gordon Bowyer (to United Kingdom Atomic Energy Authority). British Patent 968,525. Sept. 2, 1964. Filed June 25, 1962.

A remote-control manipulator having a transverse beam and flexible lines passing through the beam to interconnect a slave arm and a master arm, is designed with a gas-tight seal between the lines and the beam. (D.L.C.)

4296 IMPROVEMENTS IN OR RELATING TO PACKAGE CARRIERS. Sidney Jefferson and Frank Rogers (to United Kingdom Atomic Energy Authority). British Patent 968,723. Sept. 2, 1964. Filed Dec. 15, 1961.

An improved package carrier is designed for use in the monorail conveyor system of a package irradiation plant. The carrier, adapted to carry packages on shelves one above the other, has a shelf between packages which is hinged to the carrier and is resiliently biased to a package-loading position. When depressed by a package, the hinged shelf forms a detent for the lower adjacent package. A catch member is provided at the top of the carrier for detaining the top edge of the uppermost package. (D.L.C.)

4297 METHOD AND APPARATUS FOR THE IRRADIATION OF MATERIAL. (to Varian Associates). British Patent 968,893. Sept. 2, 1964. Priority date Aug. 24, 1960, United States.

An apparatus is designed for producing a pulsating strip electron beam for irradiating thin layers of material without the need for scanning the beam across the material. The apparatus comprises an elongated electron emitter, means for focusing the electrons into a strip beam, and pulsed anode means for intermittently accelerating the electrons. Several alternative embodiments of the apparatus are described. (D.L.C.)

4298 IMPROVEMENTS IN OR RELATING TO POWER MANIPULATORS. Eric John Fosker and Keith James Mitchell (to General Electric Co. Ltd.). British Patent 970,441. Sept. 23, 1964. Filed Aug. 2, 1962,

An arrangement for a telescopic arm for a remote manipulator is described. A sprocket wheel and chain are used to provide uniform speed of movement of the telescoping sections, thus smoothing the movement of the attached manipulator. (T.R.H.)

4299 LAMINATIONS AND LAMINATED STRUCTURES SUITABLE FOR USE IN ELECTRICAL APPARATUS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). U. S. Patent 3,147,711. Sept. 8, 1964. Priority date Feb. 17, 1960, Great Britain.

A laminated structure for electromagnetic liquid-metal pumps is described. It consists of a flattened low-alloy

ferritic steel tube, 10 ft long with a wall thickness of 0.03 in. The ends are sealed, and oxide insulation is formed inside by heating. The insulation is thus protected from erosion. (T.R.H.)

4300 MEANS FOR FOCUSING BEAMS OF CHARGED PARTICLES. John A. Hansen (to United Aircraft Corp.). U. S. Patent 3,148,265. Sept. 8, 1964. Filed Apr. 30, 1962.

An electron-beam focusing and adjusting device is described for accurate, automatic, rapid focusing in a welding or cutting machine. The beam sensor is a wobble-mounted rotating disc or a one-turn screw surface. An accurate and repeatable degree of defocusing is obtainable. (T.R.H.)

Heat Transfer and Fluid Flow

Refer also to abstracts 5394 and 5522.

4301 (AAEC/E-128) TEMPERATURES IN A SPHERE WITH DISTRIBUTED SOURCE AND VARIABLE SURFACE HEAT TRANSFER. J. J. Thompson (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1964. 10p. Dep.(mn).

An iterative perturbation theory solution is developed for a general, spherical, steady state heat conduction problem, to provide a basis for the estimation of hot spot factors for the fuel elements in a pebble bed reactor. (auth)

4302 (APL-TDR-64-117) FLOW STABILITY IN MULTITUBE FORCED-CONVECTION VAPORIZERS. P. J. Berenson (Garrett Corp. AiResearch Mfg. Div., Los Angeles). Oct. 1964. Contract AF33(615)-1551. 85p. (AD-607769). $3.00(OTS).

A description is given of work undertaken to resolve the SNAP-50/SPUR liquid-metal boiler two-phase flow stability problems. A review is presented of existing literature pertaining to forced-convection vaporization heat transfer and two-phase flow stability. Dimensionless simulation criteria are defined on the basis of the significant parameters determined from the survey. The test program, in which Freon 113 was used as the test fluid and the values of the dimensionless two-phase flow stability parameters applicable to the SNAP-50/SPUR boiler were simulated, is presented. The design of the transparent closed test loop, which incorporates a five-tube boiler, is described. Conclusions and discussions are presented, based on the measured data and the high speed photographs of two-phase flow in both plain tubes and tubes with twisted tape inserts, which indicate that stable flow can be achieved in the SNAP-50/SPUR boiler by inserting at the entrance of each boiler tube an orifice which has a pressure drop between 100 and 200 percent of the two-phase pressure drop. (auth)

4303 (BAW-1280-17) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report, September 1964. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 59p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The design criteria important in the design of steam generators are outlined. Design work on the full-size steam generator is complete, while that for the prototype is in progress. The feasibility of integral reheater steam generator design is being studied. Examination of the specimens for the sodium-heated steam generator loop tests indicate partial decarburization of Croloy 2¼ steel but not type 316 stainless steel. Data are presented for the corrosion of Croloy 2¼ steel by aqueous NaOH solutions and by Na containing NaOH additions. The analysis of Na–H_2O reaction test data for application to boiler design is discussed. (D.L.C.)

4304 (CEA-R-2439) CONVECTION FORCEE DE L'HYDROGENE LIQUIDE. PREMIERE PARTIE. CAS DE FAIBLES ECARTS DE TEMPERATURES ENTRE FLUIDE ET PAROI. (Forced Convection of Liquid Hydrogen. Part I. The Case of Small Temperature Differences Between the Liquid and the Wall). Paul Perroud and Jean Rebiere (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). Sept. 1964. 39p. Dep.(mn).

Measurements have been performed in a smooth Inconel tube of 3 mm ID, 3.5 mm OD, electrically heated (d-c) along 300 mm of its length. The liquid entered the test section subcooled at a constant temperature of 20.3°K. Pressure varied from 2 to 16 atm, mass velocity from 5 to 35 g/cm²-sec giving Reynolds numbers from 20,000 to 100,000. A formula of correlation for the heat transfer coefficients is given for the homogenous liquid phase. Burn-out phenomenon is seriously affected by flow oscillations. Effect of mass velocity and pressure on burn-out heat fluxes is discussed. Pressure drops can be calculated by considering the variation of momentum in a one-dimensional model. Head losses due to friction are negligible. (auth)

4305 (EURAEC-1109) THE APPLICATION OF THE IMPEDANCE METHOD FOR TRANSIENT VOID FRACTION MEASUREMENT AND COMPARISON WITH THE γ-RAY ATTENUATION TECHNIQUE. Special Technical Report No. 17. A. J. J. Wamsteker, C. L. Spigt, and H. F. Van Vlaardingen (Eindhoven, Netherlands. Technische Hogeschool). June 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11-RDH. 25p. (CONF-779-1; WW-016-R66). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Symposium on In-Core Instrumentation Oslo, June 1964.

A review is given of methods for void fraction measurement. A detailed description is given of the impedance method and the γ ray-attenuation method. Results of the measurements are given, showing the comparison of both methods and the use of the impedance method for the determination of the void fraction along the height of the channel, in steady and non-steady conditions. Both methods measure the void fraction without introducing any disturbance in the two-phase flow. (auth)

4306 (GEAP-4636) VISUAL OBSERVATIONS OF FLUID BEHAVIOR IN HIGH-PRESSURE TRANSITION BOILING FLOWS. E. P. Quinn and C. L. Swan (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 52p. (EURAEC-1258). Dep.(mn); $3.00(cy), 1(mn) OTS.

Preliminary motion pictures are given of high-pressure, two-phase, forced-fluid-flow behavior at the surface of a heated rod during the critical flux condition, in transition boiling, and for film boiling. Short, finned, heated surfaces were found to nearly eliminate transition boiling wall temperature fluctuations and improve film boiling heat transfer without a reduction in critical heat flux. Loop two-phase flow disturbances were found to cause excessive transition temperature fluctuations. (auth)

4307 (GN-40) PERDITA DI CARICO DOVUTA A VARIAZIONI DI QUOTA NEL MOTO VERTICALE ADIABATICO DI MISCELE BIFASICHE. (Loss of Charge Due to Variations of Contribution of Vertical Adiabatic Motion of Two-Phase Mixtures). V. Magri (Italy. Comitato Nazionale per l'Energia Nucleare, Ispra). Dec. 1963. [1962]. 14p. Dep.(mc)

The theorem of conservation of energy and the theorem of conservation of the quantity of motion (momentum equation), used to calculate the loss of charge in the adiabatic vertical motion of two-phase mixtures, lead to the same results, but the distribution of various terms that contribute to loss of charge are quantitatively and formally different. This is because a two-phase system is a heterogeneous system in which the loss of charge by friction and elevation has values and expressions different for the two phases. (J.S.R.)

4308 (NAA-SR-9477) BOILING STUDIES FOR SODIUM REACTOR SAFETY. PART II. POOL BOILING AND INITIAL FORCED CONVECTION TESTS AND ANALYSES. H. Lurie and R. C. Noyes (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. 80p. Dep.; $3.00(cy), 2(mn) OTS.

In fulfillment of the general objective of developing information on two-phase flow required in the safety evaluation of sodium cooled reactors, pool- and forced-convection

boiling of sodium were studied both experimentally and analytically. Presented are recent results obtained on the pool-boiling characteristics and the critical heat flux of saturated sodium between 0.5 and 8 psia, and also the forced convection boiling characteristics and critical heat flux for pressures of 2 and 5 psia, flow rates of 0.75 to 3 gpm, and average subcoolings of 5 to 116°F. Critical-heat-flux measurements for pool boiling on a cylindrical heater ranged from 300,000 to 1,000,000 Btu/hr-ft^2, and increased with the absolute pressure to the 0.17 power. This value is considerably lower than would be expected on the basis of results available for other liquids and on the basis of theoretical predictions. A modified, general, nondimensional correlation, which incorporates these data, is presented. The forced-convection data obtained agree quite well with established correlations for liquid metal heat transfer in annuli. Convective heat transfer seems to dominate practically up to the critical heat flux, with only a very small range of nucleate boiling heat transfer. Critical heat fluxes up to 1.5×10^6 Btu/hr-ft^2 were obtained leading to a preliminary correlation based on the superposition method of correlating boiling heat transfer. Based on this correlation, a conservative burnout margin of six was calculated for a simulated SRE-PEP reactor. The theoretical basis of a digital computer code "TRANSFUGUE" to be used for the transient analysis of single channel sodium boiling, is presented. The important computing methods were developed and a simplified two-phase flow model was programmed. (auth)

4309 (NDA-10-56(Rev.)) A COMPILATION OF SEVERAL PROPERTIES OF HIGH-PRESSURE WATER. (Nuclear Development Associates, Inc., White Plains, N. Y.). Dec. 11, 1953. For American Gas and Electric Co., New York. 29p.

Data are presented in graphical form for certain properties of water at 5000 psi which are frequently used in heat transfer and fluid flow calculations. These properties are enthalpy, specific heat, density, thermal conductivity, viscosity, specific volume-enthalpy relations, and Prandtl number. (D.L.C.)

4310 (ORNL-3605(Vol.1)) PROCEEDINGS OF 1963 HIGH-TEMPERATURE LIQUID-METAL HEAT TRANSFER TECHNOLOGY MEETING, [HELD] AT OAK RIDGE NATIONAL LABORATORY, TENN., SEPTEMBER 4-6, 1963. (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 383p. (CONF-274). Dep.; $7.00 (cy), 6(mn) OTS.

Fifteen papers are included which report on the current status of liquid-metal heat-transfer technology in the U. S. The topics discussed include thermophysical properties, thermoelectric properties, boiling heat transfer under different conditions, etc. Separate abstracts were prepared for 11 of the papers; for the remaining four, see NSA 18: 20018, 27960, 39240, and 39457. (D.L.C.)

For abstracts of individual papers see: 4311, 4312, 4313, 4314, 4315, 4316, 4317, 4654, 4655, 4656, and 5396.

4311 (ORNL-3605(Vol.1)(p.139-70)) REPORT ON HIGH TEMPERATURE LIQUID METAL HEAT TRANSFER RESEARCH AT GEOSCIENCE LTD. H. F. Poppendiek and N. D. Greene (Geoscience Ltd., Solana Beach, Calif.).

The research on liquid-metal boiling and condensing and on high-gravity or forced flow is described. Fog flow and boiling mercury studies are discussed. Some equipment for the research is described. (D.L.C.)

4312 (ORNL-3605(Vol.1)(p.240-62)) NATURAL CONVECTION HEAT TRANSFER COEFFICIENTS FOR LIQUID TIN AT HIGH HEAT FLUXES. ABL/Z. Akbar F. Brinsmade and Leland G. Desmon (Hercules Powder Co. Allegany Ballistics Lab., Cumberland, Md.).

Natural convection liquid metal heat transfer measurements were made in a rocket nozzle containing refractory metal calorimetric devices utilizing tin as a heat transfer agent. Test variables included propellant gas throat stagnation temperatures in excess of 5000°F, acceleration to 1.18 g, and heat fluxes to 1.72×10^6 Btu/hr × ft^2. Test data, a natural convection correlation for tin, and a comparison with sodium and lithium are presented. (auth)

4313 (ORNL-3605(Vol.1)(p.263-85)) THE EFFECT OF SURFACE CONDITIONS ON POOL BOILING HEAT TRANSFER OF SODIUM. P. J. Marto and W. M. Rohsenow (Massachusetts Inst. of Tech., Cambridge).

A review is presented of theoretical and experimental studies of nucleate pool boiling, and the effects of surface roughness and material on the boiling heat transfer coefficients are discussed. A static capsule apparatus is being developed for studies of the effects of different surface finishes, materials, etc. on pool boiling of sodium, and its components are described. A group discussion is included. (D.L.C.)

4314 (ORNL-3605(Vol.1)(p.286-309)) POOL BOILING OF POTASSIUM. Charles F. Bonilla, Mark M. Wiener, and Hans Bilfinger (Columbia Univ., New York).

A short review is presented of previous studies of pool boiling of liquid metals. Results are reported of preliminary pool-boiling potassium experiments, and they are compared with available correlations. An advanced potassium pool boiler for work at higher pressures, heat fluxes, and roughness is described. (D.L.C.)

4315 (ORNL-3605(Vol.1)(p.310-33)) SUPERHEAT REQUIREMENTS WITH BOILING LIQUID METALS. A. I. Krakoviak (Oak Ridge National Lab., Tenn.).

A brief review of boiling for ordinary fluids with emphasis on the wall superheat required for bubble initiation from a heated surface is presented. Calculations based on an equation valid for normal fluids indicate that superheats from two to eight times that for water are required to initiate a vapor bubble in some of the alkali metals. This high superheat and the high thermal conductivity peculiar to liquid metals are combined to explain the unstable liquid-metal boiling phenomenon in natural- and forced-circulation loops. (auth)

4316 (ORNL-3605(Vol.1)(p.334-50)) RECENT EXPERIMENTAL RESULTS IN ORNL STUDIES WITH BOILING POTASSIUM. H. W. Hoffman (Oak Ridge National Lab., Tenn.).

Recent results of continued studies into the forced-convection saturation boiling of potassium in a vertical, circular tube are reported. Heat-transfer data, for conditions below the critical heat flux, were explained in terms of an annular flow with surface evaporation. Critical heat flux values continued to agree with a correlation developed for water by Lowdermilk, Lanzo, and Siegel. A consistent pattern was observed for the pressure drop across the boiler; the data, however, include indeterminate losses at the boiler entrance and exit. New boiler sections, designed to provide data on the fluid-temperature distribution, are described. A program to obtain data on the critical heat flux in a multirod geometry as a function of rod spacing is discussed. (auth)

4317 (ORNL-3605(Vol.1)(p.351-71)) BOILING STUDIES WITH POTASSIUM. Richard E. Balzhiser (Michigan. Univ., Ann Arbor).

A brief description is given of the research program on boiling liquid metal heat transfer in all regimes. Preliminary results are discussed for the phases which utilized potassium in studies of high-flux nucleate boiling, film boiling, and forced circulation. (D.L.C.)

4318 (ORNL-3605(Vol.2)) PROCEEDINGS OF 1963 HIGH-TEMPERATURE LIQUID-METAL HEAT TRANSFER TECHNOLOGY MEETING, [HELD] AT OAK RIDGE NATIONAL LABORATORY, TENN., SEPTEMBER 4-6, 1963. (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 392p. (CONF-274). Dep.; $7.00(cy), 6(mn) OTS.

Fifteen papers are included which treat the following topics: boiling of alkali metals, properties of boiling K–Hg amalgams, condensation of liquid metals, heat transfer and pressure drop, two-phase flow, condensers, and magnetohydrodynamic generators. A summary of the meeting is included. Separate abstracts were prepared for 13 of

the papers; for the two other papers, see NSA 17: 40972 and 18: 23768. (D.L.C.)

For abstracts of individual papers see: 4319, 4320, 4321, 4322, 4323, 4324, 4325, 4326, 4327, 4328, 4657, 4873, and 4874.

4319 (ORNL-3605(Vol.2)(p.1-23)) AN EXPERIMENTAL INVESTIGATION OF FORCED-CONVECTION VAPORIZATION OF POTASSIUM. P. J. Berenson and J. J. Killackey (Garrett Corp. AiResearch Mfg. Div., Los Angeles).

An experimental program was conducted to study the boiling of potassium in the high-vapor-quality region, using a tube boiler with twisted ribbon inserts. The equipment, instrumentation, and processing of the large number of measurements in each run are described. Results are tabulated for the first test series, in which vaporization of two-phase potassium was studied. Temperature and pressure drop discrepancies are discussed. The data show that the heat transfer coefficient decreases with quality. (D.L.C.)

4320 (ORNL-3605(Vol.2)(p.24-46)) SUMMARY OF RECENT RESULTS OF SODIUM BOILING STUDIES. R. C. Noyes (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Sodium pool boiling data which were obtained recently are summarized. Forced-convection studies are discussed, and heat transfer and void measurements are reported. The loop used in the forced-convection studies is described briefly. (D.L.C.)

4321 (ORNL-3605(Vol.2)(p.64-85)) HEAT TRANSFER AND PRESSURE DROP CHARACTERISTICS FOR BOILING RUBIDIUM IN FORCED CONVECTION. C. R. Fisher (Aerojet-General Nucleons, San Ramon, Calif.).

Results are given of an experiment performed to determine the heat transfer and pressure drop characteristics of boiling rubidium in forced convection. The following ranges of operating parameters were included in this investigation: mass flow rate, 117,000-880,000 lb/hr-ft^2; saturation temperature, 1300-1800°F; heat flux, 0-325,000 Btu/hr-ft^2; inlet subcooling, 200-400°F; outlet quality, 0-0.8; test section, 0.28-in. ID smooth round tube; and pressure drop/saturation pressure, 0-0.15. (auth)

4322 (ORNL-3605(Vol.2)(p.86-109)) ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS. Joseph Longo, Jr. and Robert D. Brooks (General Electric Co. Spacecraft Dept., Cincinnati).

The research program on alkali metal boiling and condensation is described briefly. The experimental facilities (300- and 100-kw for boiling, and 50-kw for condensation) are described. The heat transfer data obtained during testing on simple geometries are given for potassium and sodium. (D.L.C.)

4323 (ORNL-3605(Vol.2)(p.153-97)) LIQUID METAL JET CONDENSERS. Lance Hays (Electro-Optical Systems, Inc., Pasadena, Calif.).

An investigation of jet condensers using mercury as a working fluid was concluded. The application which motivated this work was the use of this component as a vapor condenser in space dynamic power systems. Advantageous features such as high condensation rates, positive vapor-liquid separation, simple start-up, and significant conversion of vapor thermal energy to condensate mechanical energy were demonstrated and are discussed. Simplified expressions for momentum exchange and heat transfer were obtained and are used to correlate experimental results obtained with mercury, and to indicate trends of performance available with variations in geometric and fluid parameters. (auth)

4324 (ORNL-3605(Vol.2)(p.198-234)) FOG-FLOW MERCURY CONDENSING PRESSURE DROP CORRELATION. A. Koestel (Thompson Ramo Wooldridge Inc., Cleveland); M. Gutstein, and R. T. Wainwright (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

A theory is presented to predict the local pressure drops of mercury vapor flowing and condensing inside tubes. The theory is based on the assumption that condensation takes place at the tube wall; and, subsequently, drops are entrained into the vapor as a fine dispersion or fog. A relationship between $\phi^2 X^{\frac{1}{4}}$ and the Weber number is derived from the analysis, where ϕ^2 is the two-phase frictional pressure gradient ratio and X is the quality. Experimental data from several sources were examined and are shown to correlate well with the theory. (auth)

4325 (ORNL-3605(Vol.2)(p.235-49)) HEAT TRANSFER FROM A HOT SODIUM SPRAY IMPINGING ON A VERTICAL PLATE. W. H. Nurick, J. D. Seader, and T. A. Coultas (Rocketdyne. Div. of North American Aviation, Inc., Canoga Park, Calif.).

An experimental study was conducted on the spraying of hot liquid sodium onto an 2-in. × 0.5-in. thermocouple-instrumented test strip of Mo-0.5% Ti alloy. Heat transfer coefficients were measured and found to vary from 360 to 530 Btu/hr-ft^2-°F at sodium driving pressure of 300 to 900 psig and flow rates of 0.68 to 4.90 lb/sec-ft^2. (D.L.C.)

4326 (ORNL-3605(Vol.2)(p.250-69)) MEASUREMENT OF THE PRESSURE DROP OF SUPERHEATED CESIUM VAPOR ACROSS A LAMINAR FLOW DEVICE. William A. Samuel (MSA Research Corp., Callery, Penna.).

A study was made of the feasibility of the metering of Cs vapor in the mg/sec range by measuring the pressure drop across a laminar flow device. The results confirmed the feasibility, and the use of the method for measuring the viscosity of alkali metal vapors is suggested. (D.L.C.)

4327 (ORNL-3605(Vol.2)(p.270-92)) SELECTED PARAMETERS FOR TWO-PHASE FLOW OF SODIUM. Kurt Goldmann (United Nuclear Corp. Development Div., White Plains, N. Y.).

Some two-phase flow parameters are presented in graphic form for use in scoping designs of two-phase sodium systems. These parameters, which are based on analytic techniques, include flow patterns, pressure drop, and vapor volume fraction. A group discussion is included in which it is pointed out that the flow parameters are true only for adiabatic conditions and in which the Martinelli-Nelson derivation of pressure drop is discussed at some length. (D.L.C.)

4328 (ORNL-3605(Vol.2)(p.293-315)) STABILITY OF PARALLEL-PATH TWO-PHASE FLOW. Thomas J. Vild and Donald E. Sill (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland).

The requirements for stable operation of a parallel-tube mercury condenser capable of flowing in opposition to 1 g were investigated analytically and experimentally. Included in the analyses were the effect of geometric and thermodynamic unbalances between tubes, header pressure loss, magnitude and direction of the gravity vector, and fluid/wall contact angle. The analytical conclusions were verified by experiment on a small scale condensing apparatus and applied to a full scale prototype condenser. The results of the analyses, the small scale tests, and the testing of the full scale prototype are presented. (auth)

4329 (SAN-8003(p.134-62)) HEAT TRANSFER. (San Francisco Operations Office, AEC).

Included in heat transfer studies for nuclear superheaters are: BORAX V power distribution measurements in superheat core; BORAX V in-core instrumentation development and results of measurements; forced-convection heat transfer in superheaters; and determination of heat transfer coefficients for superheater materials and configurations. (R.E.U.)

4330 (SAN-8003(p.190-9)) STEAM-WATER SEPARATION. (San Francisco Operation Office, AEC).

Natural and mechanical separations research in progress is reported. Some experimental results for downcomer, upcomer, and crossover separators are shown. (R.E.U.)

4331 (WAPD-TM-462) A FORTRAN COMPUTER PROGRAM FOR DATA REDUCTION OF PHOTOGRAPHS OF TWO-PHASE FLOW PHENOMENA. C. S. Rogers and

E. R. Hosler (Westinghouse Electric Corp. Bettis Atomic Power Lab., West Mifflin, Penna.). May 1964. Contract AT(11-1)-Gen-14. 41p. Dep.; $2.00(cy), 1(mn) OTS.

A FORTRAN digital program is described which is used to reduce photographic or other types of growth and/or velocity data. From input consisting basically of X, Y, T coordinates for individual bubbles or other particles, the program will calculate the bubble diameter, volume and center location, vapor fraction of a specified volume, individual bubble velocity, distribution of bubble velocities across channel, liquid velocity, and slip ratio. (auth)

4332 (AEC-tr-6227/2(p.87-96)) HEAT TRANSFER IN GAS FLOW WITH A PRESSURE GRADIENT. N. Afgan and Z. Zaric. Translated from Bull. Boris Kidrich Inst. Nucl. Sci., 15: No. 2, 87-96(1964).

In a study of the effect of a positive pressure gradient on convective heat transfer, heat transfer coefficients and flow resistance were measured in annular diffusers of the type cone inside the tube for diffuser angles of 12 and 16°. The heat transfer coefficients found for both diffuser angles are above the values corresponding to an annulus of constant cross section at the same local flow velocities. The coefficients for the 8-deg half-angle are above those for the 6-deg half-angle. (auth)

4333 (AEC-tr-6227/2(p.97-112)) HEAT TRANSFER AND PRESSURE DROP OF THE REACTOR FUEL ELEMENTS WITH POLYZONAL SPIRAL FINNING. N. Afgan and S. Oka. Translated from Bull. Boris Kidrich Inst. Nucl. Sci., 15: No. 2, 97-112(1964).

To determine the heat transfer and pressure drop properties and the value and position of the minimum heat transfer coefficient on the polyzonal spiral finning of reactor fuel elements, experiments were made on an open air loop. The range of flow variation was 0.2 to 0.55 kg/sec (Re = 30,000 to 90,000), and the thermal flux from 1.2 to 4.0 kcal/m^2 sec. The experiments determined the following: (1) the distribution of the St-number over the length and perimeter of the fuel element for different Reynolds numbers and different thermal fluxes; (2) the dependence of the minimum St-number on the Re-number: $St = 4.4443 \times 10^{-2} \cdot Re^{-0.2275} \cdot Pr^{-0.6}$; (3) the dependence of the mean St-number on the Re-number: $St = 4.8242 \times 10^{-2} \cdot Re^{-0.227} \cdot Pr^{-0.6}$; and (4) the dependence of the friction coefficient on the Re-number: $f = 2.0032 \times 10^{-2} \cdot Re^{-0.05354}$. (auth)

4334 (FTD-MT-63-197) TECHNICAL GAS DYNAMICS. M. E. (Ye.) Deych. Translation of p.1-671 from "Tekhnicheskaya Gazodinamika," (a publication of the State Printing House of Energetics, Moscow–Leningrad, 1961). 637p. OTS.

Chapter headings include: fundamental concepts and equations of gas dynamics; one-dimensional motion of gas; two-dimensional motion of gas with constant entropy; compression shocks; motion of gas during presence of friction; outflow of gas from narrowing nozzles and apertures (including Laval nozzles); movement of gas in diffusers (stage of ejector); flow of gas through turbomachine cascades; flow of gas in a turbomachine stage; and methods of experimental investigation of gas flows and blading of turbomachines. 147 references. (R.E.U.)

4335 (FTD-MT-64-271) PROBLEMS OF HEAT TRANSFER AND HYDRAULICS OF TWO PHASE MEDIA (COLLECTION OF ARTICLES). Translation of p.1-392 from "Voprosy Teplootdachi i Gidravliki Dvukhfaznykh Sred," (a publication of the State Printing House of Energetics, Moscow–Leningrad, 1961). 429p. OTS.

A total of 22 articles is included which presents original experimental research on heat exchange during boiling and condensation and on hydraulics of liquid–gas mixtures. One article on organic reactor coolants was previously abstracted in NSA 18: 6425. (D.L.C.)

4336 THE EFFECT OF SURFACE TENSION ON FACTORS IN BOILING HEAT TRANSFER. John B. Roll and John E. Myers (Purdue Univ., Lafayette, Ind.). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 10: 530-4(July 1964).

High-speed photography was used to record the effects of surface tension reductions on the growth and departure characteristics of bubbles in boiling heat transfer. A model is presented to describe the manner in which surface tension has an effect upon the bubble volume, delay time, and growth time. Results obtained with this model show that surface tension is effective because it changes the nucleating properties of the liquid and not because it alters its hydrodynamic character. (auth)

4337 LATENT HEAT TRANSPORT IN SATURATED NUCLEATE BOILING. C. J. Rallis and H. H. Jawurek (Univ. of Witwatersrand, Johannesburg). Intern J. Heat Mass Transfer, 7: 1051-68(Oct. 1964).

Experimental work on the nucleate pool boiling of water at saturation is reported. This indicates that latent heat transport $(q/A)_{LH}$, is significant at all stages. The ratio $(q/A)_{LH}/(q/A)_{Tot}$ increases steadily with increasing heat flux and appears to tend to unity as $(q/A)_{Tot}$ tends toward burnout. Latent heat transport and convection together account for the total flux in saturated boiling. The basic parameters entering into the formulation of $(q/A)_{LH}$, that is, the product of bubble frequency and bubble volume — $f V_d$, and the bubble source concentration — N, were further investigated. It is shown that most published findings on the parameter $f V_d$ are inapplicable to heat-transfer correlations due to the incorrect definition of means. Experimental results show that the (arithmetic) mean product $\overline{f V_d}$ increases with the flux, and at a particular flux the product $f V_d$ is approximately the same for each bubble source. The data for N on water and on organics boiling at various pressures indicate that the relation $(q/A) = \text{constant} \cdot N^n$ where $n \sim 0.5$ appears to hold only in the region of isolated bubbles. A hypothesis is evolved and confirmed experimentally according to which the curve of N vs ΔT_{sat} takes the form of a cumulative frequency distribution. Analysis and confirmatory experiments show that nucleation and nucleate boiling cannot be made to proceed indefinitely at lower and lower pressures; for a particular surface-liquid combination a pressure exists which marks the threshold of a hitherto unrecognized regime of unstable nucleate boiling. At lower pressures the nucleate regime is altogether absent. (auth)

4338 INTERPRETING DNB DATA IN REACTOR DESIGN. L. S. Tong and H. B. Currin (Westinghouse Electric Corp., Pittsburgh). Nucleonics, 22: No. 11, 48-51(Nov. 1964).

The proper presentation and interpretation of burnout data are discussed. All independent parameters of a boiling channel are significant in presenting the data, and omitting any one of them may seriously mislead the reactor designer by distorting the effect of the parameters. Three areas of confusion that arise as a result of the particular form in which burnout data are commonly presented are discussed. These include the pressure effect, the unheated-wall effect, and the inverse mass-velocity effect. (C.E.S.)

4339 ARRANGEMENT OF THE HEATING SURFACES OF HEAT EXCHANGERS FOR A NUCLEAR REACTOR. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 969,152. Sept. 9, 1964. Priority date Jan. 23, 1962, Germany.

A heat exchanger for high-temperature gas-cooled reactors is described which avoids the disadvantages of both the "single-vessel" and "double-vessel" types of construction. The heat exchanger surfaces are arranged so that some of the surfaces (e.g., superheater) are within the reactor pressure vessel, while the others are outside (e.g., evaporator and preheater). Thus, the possibility of entry of liquid into the reactor is eliminated, and the shielding problem is reduced. (D.L.C.)

4340 IMPROVEMENTS IN HEAT EXCHANGERS. (to Clarke, Chapman and Co. Ltd.). British Patent 969,319. Sept. 9, 1964. Filed Sept. 17, 1959.

An improved heat exchanger is designed which provides a plurality of cocurrent flow paths for a fluid subject to enthalpy change. The heat exchanger includes a number of sets of helical coils of tubing, each of the sets comprising a plurality of coaxial coils of constant pitch diameter intercoiled into a multi-pass helical structure. Several embodiments of the heat exchanger are described, some for sodium-

sodium heat exchange and some for generating steam by means of liquid sodium. (D.L.C.)

Materials Testing

4341 (ACF-3) A PRELIMINARY STUDY OF THE BORE PROBLEM. PROJECT A-240. Report No. 145. James F. White (ACF Industries, Inc. Albuquerque Div., N. Mex.). Jan. 10, 1963. Contract AT(29-1)-1352. 39p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A preliminary study of the application of electromagnetic phenomenon to the examination of the surface of small bores is reported. Oxide contamination in these bores has a deleterious effect on subsequent welds. The bores are considered as sections of a hollow circular waveguide. The permissible electromagnetic field configurations are derived. The relation between attenuation and power loss is discussed, and the expression for attenuation is developed. The attenuation for various materials is presented in both graphic and tabular form. The concept of skin effect is introduced, and the various oxide layer situations are described in terms of both skin effect and attenuation. (auth)

4342 ULTRASONIC WALL THICKNESS MEASUREMENT IN A HIGHLY ACTIVE PROCESS VESSEL. R. F. Lumb. Brit. J. Non-Destructive Testing, 6: No. 2, 49-55 (June 1964).

An ultrasonic wall thickness measurement facility was installed in a reactor fuel element processing vessel, whereby changes in thickness are indicated by shifts in the displacement of the successive echoes obtained from the inner surface of the wall. For this application, probes were developed that circumvent the use of resins by bonding the piezo-electric crystal directly on to the 18/13/1 stainless steel vessel wall with a thin layer of tin. As well as retaining the crystal, the tin acts as an efficient acoustic couplant. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4343 IMPROVEMENTS IN OR RELATING TO THE TESTING OF FUEL ELEMENTS FOR NUCLEAR REACTORS. John Syme Nairn and Arthur William Shilling (to United Kingdom Atomic Energy Authority). British Patent 974,314. Nov. 4, 1964. Filed Aug. 3, 1962.

A leak tester for UO_2-containing fuel rod clusters is described. The rod cluster is heated to 300–400°C and the gas evolved is led through a system of filters and cold traps which are then counted to measure radioactivity. (T.R.H.)

4344 RADIATION METHOD OF MEASURING SHEATH THICKNESS AND ECCENTRICITY. Stephen F. Skala (to Western Electric Co.). U. S. Patent 3,148,279. Sept. 8, 1964. Filed May 4, 1961.

A method of measuring the uniformity of thickness of lead sheathing on a communications cable is described. A gamma beam penetrates the sheath and is scattered harmlessly by the inner material. The lower energy scattered rays are attenuated as they leave the cable according to the thickness of the lead sheath, thus providing a measure of the thickness. (T.R.H.)

Protective Structures

4345 IMPROVEMENTS IN OR RELATING TO PROTECTIVE EQUIPMENT TO USE WITH TOXIC SUBSTANCES. Frederick John May (to United Kingdom Atomic Energy Authority). British Patent 974,316. Nov. 4, 1964. Filed Oct. 4, 1962.

An airtight chamber with a man access tube and glove ports is described. (T.R.H.)

Vacuum Engineering

4346 ORBITRON PUMP OF 30-cm DIAMETER. Joseph C. Maliakal, Peter J. Limon, Eldon E. Arden, and R. G. Herb (Univ. of Wisconsin, Madison). J. Vacuum Sci. Technol., 1: 54-61(Nov.-Dec. 1964).

An Orbitron pump of 30-cm diameter was constructed and performance was studied as parameters were varied. The pump arrangement chosen gave pumping speed values of 105 liters/sec for argon, 4500 liters/sec for air, 6000 liters/sec for nitrogen, and 9000 liters/sec for hydrogen. (auth)

4347 ATTAINMENT OF PRESSURES BELOW 10^{-11} TORR AFTER BAKE AT 250°C. J. R. Young and F. P. Hession (General Electric Co., Schenectady, N. Y.). J. Vacuum Sci. Technol., 1: 65-6(Nov.-Dec. 1964).

The attainment of pressures below 10^{-11} torr in a vacuum system constructed of glass and stainless steel is discussed. It is shown that bakeout above 250°C for more than 15 hr is not necessary. (R.E.U.)

GEOLOGY AND MINERALOGY

General

4348 (IITRI-A6040-1) HUGONIOT DETERMINATION FOR GRANITE AND OTHER GEOLOGICAL SAMPLES. Final Report. R. S. Drennen (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Sept. 1963. For Beers (Roland F.), Inc., Alexandria, Va. Contract AT(11-1)-578. 115p. Dep.(mn); $4.00(cy), 3(mn) OTS.

The usual way of expressing the mechanical properties of materials is by an equation of state. The equation of state is the relationship existing among the thermodynamic variables of pressure temperature and density. The ease by which these state variables can be experimentally determined varies with the type of material (solid, liquid, gas), its complexity (phase changes occurring at or below the applied pressure, rate effects, etc.), and the value of the applied pressure. In addition, when the concern is with solid materials, stress and strain must be considered rather than pressure and density. Stress and strain are tensor quantities, a fact which greatly complicates the equation of state relationship. The one dimensional problem in which the applied stress, P, is in the direction of the resulting strain ϵ is considered. Thus P and ϵ may be considered as corresponding diagonal elements of the stress and strain tensors respectively. To be compatible with the usual shock wave theory this diagonal component of stress in the propagation direction of the shock wave is called pressure. (auth)

4349 (NYO-6679) AN INVESTIGATION OF THE CHEMICAL NATURE OF THE ORGANIC MATTER OF URANIFEROUS SHALES. Annual Report, January 1, 1958–December 31, 1958. C. R. Kinney, J. T. Leonard, A. A. Blash, and L. J. Duffy (Pennsylvania State Univ., University Park. Coll. of Mineral Industries). Sept. 30, 1958. Contract AT(30-1)-1442. 137p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Research on reactions of the kerogen of shale with alkaline permanganate and concentrated HNO_3 is reported. Results of investigations of oxidative degradation of Chattanooga black shale are also reported. The oxidation was achieved by the use of ozone. It was found that the chief products of ozonization are ether-soluble and water-soluble acids. Since these acids are nonbenzoid, it was concluded that the shale is mostly nonaromatic. (J.R.D.)

4350 THE ZIRCONIUM CONTENT OF CHONDRITES AND THE ZIRCONIUM - HAFNIUM DILEMMA. A. J. Erlank and J. P. Willis (Univ. of Cape Town, Rondebosch, South Africa). Geochim. Cosmochim. Acta, 28: 1715-28 (Nov. 1964).

An attempt was made to estimate the Zr content of chondrites, using an x-ray spectrographic technique, so as to resolve recent conflicting results. On the basis of eight analyses the results serve to confirm those of Schmitt. Considering both practical and theoretical observations, abundances of 13 ppm Zr and 0.20 ppm Hf were chosen for chondritic meteorites. The resulting Zr/Hf ratio of 65 necessitates no fractionation of these elements between the Earth and meteorites. (auth)

4351 FLUORINE IN STONE METEORITES. George W. Reed, Jr. (Universitilt, Bern and Argonne National Lab., Ill.). Geochim. Cosmochim. Acta, 28: 1729-43(Nov. 1964).

The fluorine content of stony meteorites was measured by ^{18}F produced by an activation technique. Different classes of chondrites, enstatite, ordinary and pigeonite–Wiik Class III, contain amounts of fluorine, 238, 121, and 66 ppm, respectively that in a sense reflect their state of oxidation. In general, the fluorine concentration within a class of stone meteorites is fairly constant. The enstatite chondrite, Hvittis, seems to be an exception. Two Ca-rich and one Ca-poor achondrites contain about 63 and 11 ppm F, respectively. An atomic abundance of 1.6×10^3 atoms $F/10^6$ atoms Si postulated by others was confirmed. (auth)

Natural Radioactivity and Fallout

Refer also to abstracts 4235 and 4739.

4352 (GAT-449) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS. FIRST HALF 1964. B. Kalmon (Goodyear Atomic Corp., Piketon, Ohio). Nov. 16, 1964. Contract AT(33-2)-1. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The environmental radiation levels and concentrations in the vicinity of the Portsmouth Area Gaseous Diffusion Plant during the first half of calendar year 1964 are summarized. The average concentrations for both alpha and beta-gamma activities in the neighboring streams, creeks, and river all indicated significant decreases compared to those previously reported. The airborne alpha activity remained essentially constant, at approximately the lowest reporting value, at about 5 percent of the maximum permissible concentration for uranium alpha. The beta-gamma airborne activity has indicated a significant decrease. The average background exposure for the first half of 1964 was 47 percent of the maximum permissible exposure if it is assumed that all the activity was due to plant operations. It has been found, however, that there is no appreciable difference between the averages on and off plantsite. The exposure rates are due to natural background and fall-out from past nuclear tests. The background indicated a large decrease over the preceding reporting periods. The over-all average concentrations for this period are compared to those for the corresponding period in 1963, the second half of 1963, and for calendar 1963. (auth)

4353 (IS-921) THE ABUNDANCE OF THE VANADIUM ISOTOPES FROM SOURCES OF GEOCHEMICAL INTEREST. Gerald D. Flesh, Jennings Capellen, and Harry J. Svec (Ames Lab., Ames, Iowa). June 8, 1964. Contract W-7405-eng-82. 24p. (CONF-520-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Mass Spectrometry, Paris, Sept. 1964.

A study was made of the possible variation of the abundance of vanadium isotopes in terrestrial sources. Mineral, reagent, and organic samples were used in the relative abundance measurements. The results show that the vanadium from all the inorganic sources has the same isotopic composition within the experimental uncertainty, while wide variations were found for organic materials. The $^{50}V/^{51}V$ ratio of the reference (reagent) is 0.002489 ± 0.000005 (absolute ratio = 0.002503 ± 0.000010). The atomic weight of vanadium is calculated to be 50.94149 ± 0.00005 on the C = 12 scale. (D.L.C.)

4354 (JÜL-190-ST) UMWELTRADIOAKTIVITÄT DER KERNFORSCHUNGASANLAGE JÜLICH. Jahresbericht 1963. (Environmental Radioactivity of the Nuclear Research Center at Jülich. Annual Report, 1963). K. J. Vogt (Kernforschungsanlage, Jülich, Germany). Mar. 1964. 83p. Dep.(mn).

Data are presented for environmental radioactivity at the Jülich Nuclear Research Center in 1963 and compared with values for 1960 through 1962. The measuring program is described and results are presented in tables and graphs. (M.C.G.)

4355 (TID-21131) ECOLOGY OF ACANTHARIA IN RELATION TO Sr CIRCULATION IN THE SEA. Period Covered: September 1963–June 1964. Bruno Schreiber (Parma, Italy. Universita. Istituto di Zoologia e Anatomia

Comparata). Contract IAEA 62/Ren.3/US. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Progress is reported in research on the ecology of plankton of the Atlantic Ocean. Emphasis was placed on studies of the various physiographic environments provided by the continental shelf, the continential slope, the Labrador Current, the Gulf Stream, the Sargasso Sea, and the Nord Equatorial Current. Radiochemical analyses of plankton samples and of marine waters confirmed the presence of ^{90}Sr, ^{155}Eu, and ^{125}Sb in plankton, and analysis of coastal sediments for fallout fission products showed that the first 4 to 6 cm retain most of the short-lived radioisotopes. (C.H.)

4356 (UCRL-12125) PREDICTION OF FALLOUT FROM SUBSURFACE NUCLEAR DETONATIONS. Joseph B. Knox (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 14, 1964. Contract W-7405-eng-48. 37p. (CONF-765-5). Dep.(mn); $2.00(cy), 1(mn) OTS.

From 2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 1964.

A numerical simulation model has been developed for the prediction of fallout from subsurface nuclear detonations that produce craters through spall and the action of the cavity gas. The physical processes modeled are atmospheric transport, lateral eddy diffusion, and gravitational sedimentation of radioactive particulates. This "cratering fallout model" is normalized to the observed external gamma dose rate fields of the Sedan (100-kt) and Danny Boy (0.43-kt) cratering events conducted at the Nevada Test Site. Calculations of the fallout patterns for additional events, used for testing the prediction capability of the cratering fallout model, indicate that the model gives estimates of the external gamma dose rate at H + 1 hours with a maximum error of a factor of 2 to 3 in the gamma dose rate versus distance along the hot line of the pattern. (auth)

4357 MEASUREMENT OF THE α RADIATION OF RADIOACTIVE DUSTS AFTER CONCENTRATION ON MEMBRANE FILTERS. Karl Schmidt. Acta Geophys. Polon., 12: 135-42(1964). (In German)

The investigations carried out on membrane filters indicated that the separation power at an exposure rate between 0.5 and 2.0 m/sec is independent of the rate. Separation of aerosols takes places within a thin filter layer and decreases approximately exponentially with the filter thickness. With the use of suitable detectors, such as thin platelets of alkali halide single crystals, the alpha particles from ^{212}Bi, ^{212}Po, ^{218}Po, and ^{214}Po on the filter can be detected separately. Within a filter loading up to 1.04 mg/cm^2 the energy resolution was practically independent of the absorption of alpha particles in the preparation. It was concluded that membrane filters are very good for measurement of α-active aerosols. (tr-auth)

4358 EXPERIMENTS TO TEST THE PRESENCE OF COSMOGENIC NUCLIDES IN OCEAN SEDIMENTS. O. A. Schaeffer, G. Megrue, and S. O. Thompson (Brookhaven National Lab., Upton, N. Y.). Ann. N. Y. Acad. Sci., 119: 347-50(Nov. 11, 1964).

An unsuccessful attempt was made to detect ^{36}Cl, ^{3}He, and ^{21}Ne, produced by cosmic-ray bombardment, in magnetic material separated from deep-sea red clay deposits. (D.C.W.)

4359 INVESTIGATIONS ON RADIOACTIVE FALLOUT. [PART] VIII. W. Gerlach and K. Stierstadt (Universität, Munich). Atomkernenergie, 9: 375-8(Sept.-Oct. 1964). (In German)

The results of fallout activity measurements during 1962 and 1963 are reported. Caused by weapon tests in the 1961/1962 period the activity increased markedly in 1962 and 1963; but did not reach the peak values of 1957. The ratio of long-lived fission products increased considerably. The storing of the ^{90}Sr was calculated and compared with direct measurements. (auth)

4360 THE TOTAL AMOUNT OF PRECIPITATION AND RADIOACTIVITY IN GERMAN SHOWERS AND THUNDERSTORMS. G. Malkowski (Freie Universität, Berlin). Atomkernenergie, 9: 379-82(Sept.-Oct. 1964). (In German)

By means of weather radar observations and certain assumptions of the variation of size and rainfall intensity of showers and thunderstorms with time the total amount of precipitation of single precipitation cells was determined in connection with values of the specific radioactivity the order of the total amount of radioactivity in showers and thunderstorms can be estimated. (auth)

4361 ARTIFICIAL RADIOACTIVITY OF THE ATMOSPHERE AND FALL-OUT DURING THE PERIOD BETWEEN JULY 1960 AND DECEMBER 1962. J. Matoušek, F. Mertl, and S. Patočka (Karlova Univ., Pilzen, Czechoslovakia). Cesk. Hyg., 9: 85-96(1964).

During the period from July 1960 to December 1962 the amount of total long-term artificial β radioactivity of the external environment (atmospheric aerosol, rain, and fallout) was studied. Due to renewed trials with nuclear weapons the radioactivity of the above constituents is constantly rising. Evidence was obtained that the increased amount of radioactivity during the spring months of 1961 and 1962 was due to long-term fission products from previous nuclear tests. (Excerpts Med., Sect. XXIII, (Oct. 1964))

4362 ISOTOPIC CONTENT AND CONCENTRATION OF LITHIUM IN STONE METEORITES. D. Krankowsky and O. Mueller (Max-Planck-Institut für Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 28: 1625-30(Nov. 1964). (In German)

The content and isotopic composition of lithium in four olivine-hypersthene chondrites, one enstatite-chondrite, one carbonaceous-chondrite, and one achondrite were determined. The lithium concentrations lie between 0.9 and 1.8 ppm. The isotopic composition was compared with that in granite G-1, diabase W-1, and lithium carbonate standard (NBS). The meteoritic and terrestrial $^{7}Li/^{6}Li$ isotope ratios agree within 2%. (auth)

4363 CARBON AND OXYGEN ISOTOPIC COMPOSITION OF MOLLUSK SHELLS FROM MARINE AND FRESH-WATER ENVIROMENTS. M. L. Keith, G. M. Anderson, and R. Eichler (Pennsylvania State Univ., University Park). Geochim. Cosmochim. Acta, 28: 1757-86(Nov. 1964).

Results are given of a systematic survey of differences in the isotopic composition of carbon and oxygen of modern mollusk shells from marine and continental environments. Marine shells analyzed show a range of $\delta^{13}C$ (relatively to Chicago PDB standard) from +4.2 to −1.7‰, whereas the fresh-water mollusk shells have relatively ^{13}C-deficient carbon, in the range $\delta^{13}C = -0.6$ to −15.2. There is a similar difference in ^{18}O content. Within the marine group, environmental sub-groups differ mainly in ^{18}O content and the differences are consistent with the temperature dependence previously studied by others. Within the fresh-water group, the most striking difference between subgroups is in the ^{13}C content of pelecypod shells from large lakes ($\delta^{13}C = -2.4$ to 6.0‰), and from rivers ($\delta^{13}C = -8.3$ to −15.2‰), a difference which is shown to be environment-controlled rather than species-controlled. The soft parts of pelecypods also show characteristic differences of carbon isotopic composition from marine to lacustrine to fluvial specimens. The ligament of pelecypods is found to consist partly of aragonite fibers, which are isotopically different from shell carbonate. It was concluded that the carbon isotope ratio in mollusk shells is considerably influenced by the proportional amount of land-plant derived carbon included in the food of the mollusks or contributed by humus decay to dissolved bicarbonate in the water. It appears likely that the observed isotopic differences can be applied to the environmental study of fossils and sedimentary carbonate rocks, and to the source identification of shell artifacts of archaeological interest. (auth)

4364 CARBON AND OXYGEN ISOTOPIC COMPOSITION OF SELECTED LIMESTONES AND FOSSILS. M. L. Keith and J. N. Weber (Pennsylvania State Univ., University Park). Geochim. Cosmochim. Acta, 28: 1787-1816(Nov. 1964).

Isotopic analyses are presented for 500 samples of marine and freshwater limestones and fossils. Mean carbon

isotopic compositions, in the conventional δ-values, relative to the Chicago PDB standard, were +0.56 per mil (selected marine group) and −4.93 per mil (selected freshwater group); mean oxygen isotopic compositions were −5.25 per mil (marine) and −8.66 per mil (freshwater samples). The average carbon isotopic composition of marine limestones was nearly constant from the Cambrian age group to the Tertiary group and it was concluded that no great change has occurred in the carbon isotopic composition of marine bicarbonate over geologic time. Oxygen isotopic compositions of marine limestone exhibit a progressive increase in average oxygen-18 content from the oldest to the youngest age group, possibly due mainly to post-depositional recrystallization and oxygen exchange in the presence of waters different from those of the original environment. Mean $\delta^{18}O$ was −9.7 per mil for the selected Cambrian group, −1.2 per mil for the Quaternary sample group. Average carbon and oxygen isotopic compositions of freshwater limestones show less regular changes with time of formation. Carbon isotope ratios were significantly different from those of marine limestones in sample groups as old as Carboniferous or Devonian, whereas oxygen isotope ratios differ in marine and freshwater sample groups as old as Jurassic. A graphic plot of $\delta^{13}C$ versus $\delta^{18}O$ gave environmental separation of more than 80% of the samples, and the percentage of correct diagnosis was considerably improved in Jurassic and younger samples. It was concluded that carbon and oxygen isotopic compositions of limestones and calcareous fossils provide significant but not infallible criteria of depositional environment for samples of a wide range of geologic age. The difference in ^{13}C content between marine and freshwater carbonates was attributed mainly to a variable contribution of ^{13}C-deficient carbon from land plants and humus, which is added to freshwater systems in several stages, but has a relatively minor influence in most marine environments. (auth)

4365 PRELIMINARY Rb−Sr INVESTIGATION OF TERTIARY GRANITE AND GRANOPHYRE FROM SKYE. Leon E. Long (Univ. of Texas, Austin). Geochim. Cosmochim. Acta, 28: 1870-3(Nov. 1964).

Evidence is reported that shows that rocks of the plutonic phase were emplaced during the Eocene. Samples of igneous rock were analyzed by isotope dilution for Rb and Sr concentration and Sr isotopic composition. Studies were made to determine the age of the Beinn an Dubhaich granite and of the Coire Uaigneich granophyre, and their origin using $^{87}Sr/^{86}Sr$ ratios. The isochron slope corresponds to an age of 52 ± 3 my and the intercept gives a value of 0.715 ± 0.003 for initial $^{87}Sr/^{86}Sr$. The early Eocene age, as indicated by a recent time scale is not inconsistent with the Eocene age of the somewhat older plateau basalts in Skye. The initial $^{87}Sr/^{86}Sr$ ratio (0.715) of the Beinn an Dubhaich granite is significantly higher than an initial value of 0.708 commonly observed from a variety of igneous rock types and suggests that the derivation of at least a portion of the magma from Rb-rich sialic material. (P.C.H.)

4366 CONCENTRATIONS OF RADIOACTIVE PARTICLES IN SURFACE AIR NOVEMBER 1962 THROUGH 1963. Charles A. Pelletier, Audrey V. Wegst, and G. Hoyt Whipple (Univ. of Michigan, Ann Arbor). Health Phys., 10: 917-21(Dec. 1964).

Weekly samples of airborne dust, collected in south eastern Michigan from November 1962 through March 1963, were counted for β activity and then autoradiographed. For a 7-day exposure, the smallest particle activity that the radiographic film could resolve was about 0.01 μμC. For the samples collected in November 1962, it is shown that 34% of the total β activity could be accounted for on particles with activities less than 0.01 μμC. In March 1963, 91.5% of the total radioactivity could be accounted for on particles with activities less than 0.01 μμC. Using certain assumptions concerning the distribution of particles below 0.01 μμC, it is estimated that the concentration of radioactive particles was $2 \times 10^4/m^3$ in November 1962 and $3 \times 10^4/m^3$ in March 1963. The average activity of the particles collected in November 1962 was 5×10^{-4} μμC and 2×10^{-4} μμC in March 1963. (auth)

4367 RADIONUCLIDE CONTENT OF AIRBORNE PARTICLES, 1962-1963. J. Hardin, S. Gold, B. Kahn, and C. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati). Health Phys., 10: 923-31(Dec. 1964).

Radionuclide levels observed in Cincinnati air from May 1962 through December 1963 are reported and the significance of relative fission product concentrations is discussed. An attempt was made to relate the levels found to the radiation exposure. Air particulate samples were collected daily on glass fiber filters, and the fallout radionuclides associated with these particles were identified by gross beta counting, gamma spectral analyses and radiochemical analyses. With these techniques, ten gamma-emitting fission products and ^{54}Mn and ^{57}Co were identified and measured. (auth)

4368 HUMAN HAIR AND STRONTIUM 90. Dade W. Moeller, Edmond J. Baratta, and Ira E. Leonard (Public Health Service, Winchester, Mass.). Public Health Rept. (U. S.), 79: 1030-1(Nov. 1964).

The use of human hair as an indicator of the intake and body burdens of ^{90}Sr was investigated during 1963 in Boston, New Orleans, and Phoenix. The first two cities were representative of areas of relatively high environmental ^{90}Sr levels and the last city was representative of a relatively low ^{90}Sr area. Preliminary results indicate that a correlation may exist between ^{90}Sr content in human diet and human hair. More extensive tests are planned. (C.H.)

4369 ON THE ANNUAL COURSE OF AIR RADIOACTIVITY CAUSED BY THE LONG-LIFE ALPHA EMITTERS. B. Styra, Č. Garbaliauskas, T. Nedveckaite, J. Tomkus, and K. Šopauskas (Inst. of Geology and Geography, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 131-41(1964). (In Russian)

Applying the method of dynamic activation of the nuclear photographic emulsion and adopting a proper photographic exposition regime, it is possible to deduce from the general atmospheric radioactivity the uranium-thorium component. Daily observations of this kind were carried out during a 7 months period in 1958–1959. There were revealed radioactivity peaks caused by the clouds of radioactivity dust of artificial origin passing the observation point. The background radioactivity, it appears, is conditioned by two components: the diffuse radioactivity from contaminating clouds in the atmosphere and that which repeatedly got there from the earth's surface in dust particles due to a turbulent mixing of the atmosphere. The meteorological conditions of the radioactivity peak formation are studied, and an attempt is made to ascertain the relation between the background radioactivity and the conditions of atmospheric circulation as well as weather types during the period under investigation. (auth)

4370 ON SOME PROBLEMS CONNECTED WITH RADIOACTIVE FALLOUT IN THE ATMOSPHERE. C. Garbaliauskas (Inst. of Geology and Geography, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 143-54(1964). (In Russian)

During the period of March−October, 1959, the observations of the atmospheric precipitation and of dry fallout radioactivity were carried out. The samples were collected daily by the sedimentation method, placing for this purpose a cuvette with distilled water (1600 m^2). Simultaneously the quantity of atmospheric precipitation was recorded by means of a pluviograph. After evaporating the water and burning the filter paper with sediment, the long-living radioactivity of every sample, 24 hours after its collection, was measured by means of an end-window counter. The results obtained showed that the radioactivity washed out by precipitation constitutes over 80% of all fallout radioactivity. The sudden decrease of radioactivity level during the observation period is explained, chiefly, by the discontinuance of the nuclear weapon tests and, partly, by the possible annual course of radioactive fallout being

reflected in it, as having the minimum value in late autumn. The effective half-period of the troposhere scavenging for coarse aerosol with long-living radioactivity component for the whole period of observation on the average reached 2 months, its value, evidently, being conditioned on the one hand by the stratospheric sedimentation and on the other hand by the dust repeatedly returning to the atmosphere from the surface of the earth. With the increase of the diurnal amount of the atmospheric precipitation, there was observed an ever increasing effect of dilution of the radioactive matter in the precipitation water. In connection with this it was found that the ratio of the total sum of the values of the specific precipitation radioactivity and that of the dry fallout to the radioactivity of the dry dust subsiding during the same period of time (the scavenging factor) characterizes the effectiveness of the troposphere scavenging mechanism. (auth)

4371 VERTICAL DISTRIBUTION OF RADIONUCLIDES AS MEASURED IN OCEANIC ANIMALS. William G. Pearcy and Charles L. Osterberg (Oregon State Univ., Corvallis). Nature, 204: 440-1(Oct. 31, 1964).

This work shows that radioactivity/g of oceanic animals may demonstrate different patterns of depth distribution for different radioisotopes. Moreover, since ^{65}Zn is ubiquitous in marine animals off Oregon, vertical migrations of biomass will result in a vertical flux of radiozinc. It is interesting that the largest day-night changes in ^{65}Zn/1,000 m^3 occurred across the depth of 150 m, a depth which corresponds approximately to the halocline and a rapid density change that impedes vertical mixing by physical processes in this portion of the Pacific Ocean. Further generalizations based on these limited data are obviously unwarranted, as little is known of temporal or spatial variations of these radionuclides associated with oceanic animals. (auth)

4372 URANIUM DISTRIBUTION IN DRAKE PASSAGE WATERS. Y. Sugimura (Meteorological Research Inst., Tokyo), T. Torii, and S. Murata. Nature, 204: 464-5 (Oct. 31, 1964).

Information on the distribution of uranium in Antartic waters was collected to investigate oceanic circulation. Surface water analyses and two vertical distribution tests were conducted in Drake Passage. Fairly constant values of uranium were obtained in the surface samples, averaging $3.1 \pm 0.2 \times 10^{-6}$ g/l. In its vertical distribution uranium tended to show a minimum concentration about the depth of 300 to 400 m, increasing at greater depth. (H.M.G.)

4373 ARTIFICIAL AND NATURAL RADIOACTIVITY IN THE ATMOSPHERE AND IN ATMOSPHERIC PRECIPITATION. [PART] I. Margrit Lesigang (Universität, Vienna). Oesterr. Chemiker-Ztg., 64: 368-74(1964). (In German)

Two ways in which radioisotopes are introduced into the atmosphere are discussed. They are: diffusion from the earth's crust and formation in the atmosphere by cosmic radiation. Products formed by neutron capture are described. Spallation products are also considered. Circulation and atmospheric lifetimes of the radioisotopes are discussed. (M.C.G.)

4374 ARTIFICIAL AND NATURAL RADIOACTIVITY IN THE ATMOSPHERE AND IN ATMOSPHERIC PRECIPITATION. [PART] II. Margrit Lesigang (Universität, Vienna). Oesterr. Chemiker-Ztg., 65: 13-19(1964). (In German)

The occurrence of artificial radioactivity in the atmosphere, due chiefly to nuclear weapons tests, is discussed. The presence of aerosols, fallout, environmental fallout, tropospheric fallout, stratospheric fallout, circulation of the atmosphere, and atmospheric lifetimes of the radioisotopes are considered. The fallout present in precipitation is also discussed. (M.C.G.)

4375 THE CERIUM—PRASEODYMIUM FRACTION OF THE LONG-LIVED RADIOACTIVITY IN THE ATMOSPHERE. Wolfgang Marquardt. Z. Meteorol., 14: 55-6 (Feb. 1960). (In German)

Atmospheric lifetimes of several long-lived fission products were studied. Beta energies of the various isotopes were determined and absorber curves (for aluminum foils) were obtained. Since beta particles of various energies are absorbed at different depths, a separation of components of the spectra can be achieved. It was concluded that 59% of the total activity of the long-lived fission products in the atmosphere and in fallout have their beginning in ^{144}Ce and ^{144}Pr. (M.C.G.)

4376 UMWELTRADIOAKTIVITÄT UND STRAHLENBELASTUNG. BERICHT I/64. (Environmental Radioactivity and Radiation Burden. First Quarterly Report, 64). Bad Godesberg, Ger., Bundesminister fur Wissenschaftliche Forschung, 1964. 232p. 10 DM.

The content of radioactive materials in air, water, soil, and food materials and the radiation burden of the population in the German Federal Republic, measured during the first quarter of 1964, are reported in graphic and tabular form. (J.S.R.)

4377 RADIATION LEVELS. AIR, WATER AND FOOD. A. S. McLean, S. G. Burgess, E. Windle Taylor, R. Scott Russell, and E. R. Mercer. London, The Royal Society of Health, 1964. 59p.

Separate abstracts were prepared for two papers included. The benefits of atomic energy are discussed briefly in a third paper that was not abstracted separately. A fourth paper was abstracted previously in NSA 18: 39501. (C.H.)

For abstracts of individual papers see: 4378 and 4379.

4378 RADIATION IN AIR. S. G. Burgess. p.9-22 of "Radiation Levels. Air, Water and Food." London, The Royal Society of Health, 1964.

Contamination of air by radioactive matter can be caused by natural sources, fallout from nuclear explosions, nuclear reactors, or accidental discharge. The possible effects of radiation in air and the degree of delay in their manifestation are varied and depend on many factors, the most important of which are the chemical nature of the material, the physical nature, the amount reaching the body, the part of the body having contact, the radioactive half-life of the material, the type of radiation emitted, the level of energy of the radioactivity, the movement and metabolism of the material within the body, and the excretion rate. It is pointed out that man has been exposed to ionizing radiation from radioactive isotopes and other sources since the beginning of his history and it may be that this natural radiation is less today than in past ages. The biological effects of radiation are reviewed and acceptable limits for radioactive pollution of the atmosphere are defined. Methods used in the establishment of these maximum permissible levels of atmospheric radioactivity are discussed. It is concluded that the growing use of radioactive isotopes does not constitute an air contamination danger if proper conditions of storage and use are applied. The fallout contamination in 1962 had not reached a level in the air which should cause alarm. (C.H.)

4379 RADIATION IN WATER. E. Windle Taylor. p.23-41 of "Radiation Levels. Air, Water and Food." London, The Royal Society of Health, 1964.

Factors contributing to the contamination of water supplies by α and β activity from natural and artificial sources are discussed. Results are reported from a survey on the incidence of cancer and leukemia in residents of regions with high concentrations of ^{226}Ra and Rn in water supplies that showed no increase due to radioactivity of drinking water. It is pointed out that the most important source of widespread artificial activity is from fallout resulting from nuclear explosions in the atmosphere, since the discharge of radioactive wastes to rivers is carefully controlled. The most biologically significant radioactive constituents of fallout are the long-lived isotopes ^{90}Sr, ^{89}Sr, and ^{137}Cs. Iodine-131 loses its activity so rapidly that it is not a hazard in water supplies. Monitoring programs in effect to detect radioactivity in water supplies are discussed. (C.H.)

Site Survey and Selection

Refer to abstract 5398.

Techniques and Equipment

4380 TECHNIQUES FOR GEOLOGICAL DATING OF MINERALS BY CHEMICAL ETCHING OF FISSION FRAGMENT TRACKS. R. L. Fleischer and P. B. Price (General Electric Research Lab., Schenectady, N. Y.). Geochim. Cosmochim. Acta, 28: 1705-14(Nov. 1964).

Suitable chemical etching treatments are described for revealing fission tracks in a variety of minerals, and rules are given for distinguishing fission tracks from dislocation and other defects. Dating results are given for two hornblendes and an apatite as examples of the procedures. Track studies also give a sensitive measure of the present and past distribution of uranium atoms in minerals. (P.C.H.)

4381 AGE DETERMINATION OF GRANITES OF SOUTH-WESTERN KARELIA KARELIDES WITH THE AID OF THE Rb–Sr-ISOCHRONOUS METHOD. I. M. Gorokhov and S. B. Loback-Zhuchenko (Precambrian Geology Lab., Leningrad). Geokhimiya, No. 10, 980-7(1964). (In Russian)

The age of leucocratic granites of the last magmatism stage of South-western Karelian lower karelides was determined by the Rb–Sr-isochronous method on 8 rock samples in the whole. The value obtained is 2190 million years, which agrees well with the age of pyrite deposits of karelides in Karelia and Finland. (auth)

4382 FISSION-TRACK AGES OF ZIRCONS. R. L. Fleischer, P. B. Price, and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). J. Geophys. Res., 69: 4885-8(Nov. 15, 1964).

The fission-fragment-track dating method was applied to zircons ranging in age from less than 10^6 yr to more than 10^9 yr. Good agreement was obtained with ages determined by standard methods. Uranium concentrations were measured, and the microscopic distribution of uranium was studied. It was found that no movement of uranium had taken place over geologic time. Crystals as small as a few micrograms can be dated. In principle, ages from a few hundred years to several billion years can be measured by selecting crystals with suitable concentrations of uranium. (auth)

4383 INITIAL Sr^{87}/Sr^{86} AND POSSIBLE SOURCES OF GRANITIC ROCKS IN SOUTHERN BRITISH COLUMBIA. H. W. Fairbairn, P. M. Hurley, and W. H. Pinson (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 69: 4889-93(Nov. 15, 1964).

Whole-rock strontium isotopic analysis of twenty-two post-Jurassic granitic rocks from southern British Columbia, selected from about eighty field localities, gives a range of values of $^{87}Sr/^{86}Sr$ from 0.705 to 0.710. The age correction is insignificant for samples of very low Rb/Sr, and for the remainder it is based on published K–Ar biotite ages (45 to 86 × 10^6 yr). The corrected ratios are significantly higher than the means (0.704 to 0.705) established for mantle-derived oceanic and continental basalt. The ratios are, on the other hand, so much lower than those for the average continental crust (0.725 + 0.005) and composite shales (0.7204, 0.7226) that a source for the granitic magma in the upper crust is believed to be unrealistic. The magma is therefore assumed to have originated either from a gabbroic layer at the base of the crust or in the upper mantle itself and to have been slightly enriched in ^{87}Sr as it passed upward. A plot of uncorrected $^{87}Sr/^{86}Sr$ and $^{87}Rb/^{86}Sr$ shows one isochron of moderate quality 58 ± 6 × 10^6 yr, which is in general agreement with K–Ar biotite ages for many of these intrusives. (auth)

4384 POTASSIUM–ARGON AGE STUDY OF POSSIBLE LOWER-CRUST AND UPPER-MANTLE INCLUSIONS IN DEEP-SEATED INTRUSIONS. J. F. Lovering and J. R. Richards (Australian National Univ., Canberra). J. Geophys. Res., 69: 4895-4901(Nov. 15, 1964).

The K-Ar ages were measured for various minerals separated from possible lower-crust (granulitic) and upper-mantle (eclogitic) materials which occur as xenoliths in igneous pipes of deep-seated origin at Delegate (Australia), Roberts-Victor mine (South Africa), and Salt Lake Crater (Oahu, Hawaii). Minerals separated from granulitic and some eclogitic xenoliths have apparent K-Ar ages consistent either with their formation at the time the pipes were intruded (168 × 10^6 yr for the Delegate pipe, 68 × 10^6 yr for the Roberts-Victor pipe) or with loss of any pre-existing radiogenic Ar at that time. However, K-Ar dates measured on clinopyroxenes and phlogopite from certain eclogitic xenoliths suggest that these particular xenoliths have apparent ages very much in excess of the host intrusion. It is suggested that these great ages may result from excess radiogenic Ar incorporated in the mineral lattice under conditions of locally high Ar partial pressures. These conditions could have existed either within the mantle (if the xenoliths are of accidental origin) or at depth in the host magma (if cognate). (auth)

4385 GAMMA-SPECTROMETRIC ANALYSIS OF NATURAL LOW-ACTIVITY ROCKS EMPLOYED IN PETROGENETIC INVESTIGATIONS, STUDIES OF MINERAL DEPOSITS, AND AS A RAPID METHOD FOR THE ROUGH ESTIMATION OF THE AGE OF ROCKS. R. Lauterbach. Kernenergie, 7: 622-8(Aug. 1964). (In German)

A highly sensitive gamma-ray spectrometer of moderate size permits a non-destructive investigation of small mineral specimens. Some of the results are discussed. Using the spectrometer provides interesting information about the origin of rocks, the geological position of ore deposits or the presence of volcanic dikes at great depths in the earth's crust. The method suggests improved possibilities for the detection of oil deposits and may possibly be used as a rapid method for assessing the age of rocks. The technique has been tested for its application in archaeology and for well-known meteorological uses. (auth)

4386 RUBIDIUM–STRONTIUM ISOCHRON STUDY OF THE GRENVILLE FRONT NEAR LAKE TIMAGAMI, ONTARIO. James A. Grant (California Inst. of Tech., Pasadena). Science, 146: 1049-53(Nov. 20, 1964). (TID-21192)

Rubidium–strontium isotopic analyses of whole-rock samples and of constituent minerals from a suite of rocks taken across the Grenville Front demonstrate that granitic rocks of the Superior province, with a primary age of approximately 2.4 billion years and older metasedimentary rocks were reconstituted during Grenville metamorphism, at approximately 930 million years, and now form part of the Grenville province. (auth)

Thorium and Uranium Minerals

4387 (RME-4553(Rev.)) RECONNAISSANCE FOR URANIUM IN WEST-CENTRAL PERU. John W. Gabelman (Division of Raw Materials, AEC and Peru. Junta de Control de Energia Atomica, Lima). Oct. 1963. 22p. Dep.; $2.00(OTS).

In brief reconnaissance of six areas on the western slope of the Andes Mountains in west-central Peru weakly anomalous radioactivity was found to be commonly associated with epithermal mineralization. Most hydrothermal mineralization on the western side of the Andes was hypothermal, rarely grading to mesothermal on the margins of strong mineralization centers but regionally grading to mesothermal along the crest of the mountains. Local, nearly contemporaneous gradations to epithermal are unknown, but much later, more shallow epithermal mineralization was locally superimposed on the same region. The epithermal to surficial environment is the most favorable for uranium, and its association with radioactivity in the areas visited is generally a favorable indication. Larger and richer ura-

nium deposits might be found by investigating more thoroughly the few known sectors of lowest temperature mineralization. However, uranium should be more abundant on the eastern slope of the Andes where the majority of deposits are epithermal. (auth)

4388 (RME-4565(Rev.)) RECONNAISSANCE FOR URANIUM IN THE CHANARAL-TALTAL AREA, PROVINCES OF ANTOFAGASTA AND ATACAMA, CHILE. William A. Bowes, Paul H. Knowles, Aldo Moraga B., and Mario Serrano C. (Division of Raw Materials, AEC and Chile. Instituto de Investigaciones Geologicas, Santiago). Dec. 1961. 28p. Dep.; $2.00(cy), 1(mn) OTS.

In the Chañaral-Taltal area of northern Chile irregular replacement-type iron deposits are especially well developed along a somewhat radioactive lithologic belt in andesite volcanic rocks and Cretaceous dioritic intrusions to the east of the Atacama fault, a prominent shear zone. The Atacama fault and its related structures host important copper deposits along a "structural" belt; uranium is a minor associate. The best showings of radioactivity are in the Las Animas district where a thin layer of radioactive minerals lies on the margin of high-temperature chalcopyrite-pyrite ore bodies in Cretaceous granitic rocks. The uranium, along with alteration products of earlier high-temperature minerals, is confined to vein walls, and the quantity of uranium mineralization is roughly proportional to that of the pyrite and chalcopyrite. (auth)

4389 GEOLOGY OF URANIUM DEPOSITS. Juan Sosa Benites. Bol. Junta Control Energia At. (Peru), 9: No. 48, 29-44(Jan.-Mar. 1964). (In Spanish)

Uranium minerals are classified and their characteristics are summarized. The classification of uranium deposits is given, and the most important deposits in each classification are listed. (J.S.R.)

4390 ABSOLUTE AGE OF THE PRE-CAMBRIAN ROCKS OF THE KURSK MAGNETIC ANOMALY. A. I. Tugarinov, E. V. Bibikova, and S. I. Zykov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 10, 988-94(1964). (In Russian)

Results of age determinations with the aid of the Pb–U–Th-method are reported for the metamorphic and magmatic complexes of the Kursk magnetic anomaly. The age of the crystalline basement is more than 2750 b.y. The accumulation of basal rocks of the Kursk series is an age of about 2600 b. y. Two main processes are responsible for the migration of radiogenic lead–the metasomatic alteration of rocks in connection with magmatic activity 1900–2100 b. y. ago and surface weathering in recent time. (auth)

HEALTH AND SAFETY

Refer also to abstracts 3824, 4086, and 5395.

4391 (AD-450228) ANALYSIS OF POSTATTACK FOOD PROCESSING AND DISTRIBUTION. Progress Report. John W. Billheimer and Harvey L. Dixon (Stanford Research Inst., Menlo Park, Calif.). June 1964. Contract OCD-OS-62-135. 116p.

The initial phases of a study designed to model the effects of the food processing and distribution system of the United States on the postattack flow of contaminated foodstuffs is described. A modeling method is proposed that employs utilization charts, seasonal supply graphs, and various production-consumption time lags to provide a quantitative description of commodity flow patterns. These quantitative indices are assigned postattack values through the use of damage assessment procedures designed to fit existing food inventory data. The techniques proposed in this report are used to describe the probable processing and distribution patterns followed by milk and wheat products after a mixed counterforce and city attack based on a high threat level. (auth)

4392 (AD-450598) RADIOLOGICAL RECOVERY CONCEPTS, REQUIREMENTS, AND STRUCTURES. FINAL REPORT. VOLUME II. SPECIFIC CONSIDERATIONS AND SUPPORTING DOCUMENTS. J. T. Ryan, J. D. Douglass, Jr., and H. E. Campbell (Research Triangle Inst., Durham, N. C.). Oct. 16, 1964. Contract OCD-PS-64-56. 309p.

This study examines the effectiveness and costs associated with the application of decontamination to accelerating recovery of an activity in a postattack fallout environment. The effectiveness is measured in two ways: first, by the fractional reduction in dose rate that can be achieved by decontamination, and second, when the dose received during the activity is specified, by the fractional reduction in denial time that can be achieved by decontamination. The costs are described in terms of the personnel and equipment required for the decontamination, the radiation doses received by the personnel, and the water required by the operation. The recovery of an activity is defined in terms of radiation doses received by the activity personnel in performing the activity. When these doses are reduced to an acceptable safety level by reducing the dose rate in the activity area, the activity is said to be recovered. The above dose constraints are expressed both in terms of the maximum total dose and in terms of the maximum equivalent residual dose. The primary conclusion reached, that decontamination is as vital to recovery as shelters are to survival in a fallout environment, is the basis for recommending further studies analyzing the application of decontamination to integrated whole-city recovery. (auth)

4393 (AD-450606) RADIOLOGICAL RECOVERY CONCEPTS, REQUIREMENTS, AND STRUCTURES. VOLUME I. GENERAL CONSIDERATIONS. Final Report. J. T. Ryan, J. D. Douglass, Jr., and H. E. Campbell (Research Triangle Inst., Durham, N. C.). Oct. 16, 1964. Contract OCD-PS-64-56. 46p.

The effectiveness and costs associated with the application of decontamination to accelerating recovery of an activity in a postattack fallout environment is examined. The effectiveness is measured in two ways: first, by the fractional reduction in dose rate that can be achieved by decontamination, and second, when the dose received during the activity is specified, by the fractional reduction in denial time that can be achieved by decontamination. The costs are described in terms of the personnel and equipment required for the decontamination, the radiation doses received by the personnel, and the water required by the operation. The recovery of an activity is defined in terms of radiation doses received by the activity personnel in performing the activity. When these doses are reduced to an acceptable safety level by reducing the dose rate in the activity area, the activity is said to be recovered. The above dose constraints are expressed both in terms of the maximum total dose and in terms of the maximum equivalent residual dose. The primary conclusion reached, that decontamination is as vital to recovery as shelters are to survival in a fallout environment, is the basis for recommending further studies analyzing the application of decontamination to integrated whole-city recovery. (auth)

4394 (CONF-555-7) THE ROTATING DISK AS AN AEROSOL SAMPLER IN THE SUBMICRON RANGE. S. K. Friedlander and Ralph E. Pasceri (Johns Hopkins Univ., Baltimore). [1964]. Contract [AT(30-1) -1371]. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

When a flat disk is rotated about the axis normal to its face, a flow is induced over the surface of the disk. The velocity distribution can be calculated from theory if the fluid at a large distance from the disk is stagnant. Theory predicts and experiment confirms that when a component of the fluid diffuses to the disk, the flux of that component has the same value all over the surface provided that the surface concentration is constant. This effect has been applied to the sampling of submicron aerosol particles. A one-inch disk with an electron microscope slide fixed to its surface was rotated for several hours at a speed of about 2,000 rpm in room air. From the size distribution of the deposited particles, determined by electron microscope examination, distribution of the particles in the air was calculated for the range between 70 Å and 0.1 microns diameter. This new sampling method has a number of important advantages: It is very simple. It provides a large surface over which deposition is uniform. The relation of the distribution of the deposited sample to the distribution in the gas is known from theory. Efficiency of removal increases as particle size decreases. The method should be easily adaptable to autoradiographic techniques. In a study of the size distribution of the Baltimore aerosol a simple new method has been used to sample the particle size range smaller than a few tenths of a micron in diameter. Particles were collected from room air by Brownian diffusion to an electron microscope grid placed at the center of a one-inch stainless steel disk rotated about the axis normal to its face. (auth)

4395 (HW-71744) NON-RADIOACTIVE TESTING OF THE HAPO I-2 FISSION PRODUCT SHIPPING CASK. W. V. DeMier (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 19, 1962. Contract AT(45-1)-1350. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A cerium-sodium sulfate precipitate, $Na_2SO_4-Ce_2(SO_4)_3$ was successfully filtered on the HAPO I-2 shipping cask filter without recourse to filter aid. The self-limiting flow feature of the cask was demonstrated. The capacity of the filter was determined to be 1000 ± 100 grams of cerium. Recovery as filter cake was about 97 percent. Low-speed agitation at 0.0015 horsepower per gallon was not sufficient to keep all of the finely divided copper powder (used as a cake dissolution aid) in suspension in the feed tank. Settling of copper in the transfer lines was observed as slurry flow rates decreased near the end of the loading operation. Dissolution of the dried cake was accomplished with two passes of 4 molar nitric acid. Fifty gallons of the acid were drawn through the cask slurry nozzle by means of vacuum applied at the filtrate nozzle; then connections were reversed and the acid was recycled as a backflush. The 4600-watt, 230-volt heater operated successfully during drying of the cake in the first run, but developed an internal short upon cooling, preventing its use during the second run. (auth)

4396 (HW-77295) RADIATION PROTECTION ASPECTS OF THE RECUPLEX INCIDENT OF APRIL 7, 1962. C. M. Unruh, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 14, 1962. Revised May 1963. Contract AT(45-1)-1350. 108p. Dep.(mn); $4.00(cy), 2(mn) OTS.

On Saturday morning, April 7, 1962, a nuclear excursion occurred in the K-9 tank of the Recuplex process during the transfer of plutonium liquid solution into the K-9 tank. A review is presented of the radiation protection aspects of the event. These aspects include criticality alarms, evacuation, radiochemical analyses of biological samples from the affected employees, dose estimation and control, personnel and traffic control, environment, radiation instrumentation, etc. (D.L.C.)

4397 (HW-83602) PROGRESS IN ATMOSPHERIC PHYSICS. A Summary of Hanford Laboratories Work on This Program Under General Electric, 1959–1964. J. J. Fuquay, comp. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 50p. Dep.; $2.00(cy), 1(mn) OTS.

Micrometeorological research directed toward problems associated with predicting the levels of dosages and concentrations in the environment resulting from release of contaminant materials to the atmosphere is summarized. A review of advances in atmospheric tracer technology is included along with a summary of precipitation scavenging research. The micrometeorological data collected in support of the experiments are analyzed. (J.R.D.)

4398 (IDO-12037) HEALTH AND SAFETY DIVISION ANNUAL PROGRESS REPORT, 1963. Aubrey O. Dodd, ed. (Idaho Operations Office. Health and Safety Div., AEC). Aug. 1964. 97p. Dep.; $3.00(cy), 2(mn) OTS.

Significant health and safety data characterizing the protection program for over 5000 persons at the National Reactor Testing Station in southeastern Idaho during 1963 are summarized. Emphasis is placed on the major innovations, concepts, and new trends. Repetitive information, essential for perspective in a continuing program, has been kept to a minimum, allowing space for reporting developments considered to be of special interest to persons working in the field of health and safety. Data are included on industrial and clinical medical examinations, radiation dosimetry, analytical chemistry developments, hazards control, health physics activities, radioactive waste disposal, design modifications for radiation detectors, design of a portable whole-body counter, and meteorological studies. (C.H.)

4399 (LA-DC-6679) THE ROLE OF THE HEALTH SURVEYOR. R. J. Miller (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 11p. (CONF-808-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Industrial Hygiene Assn. Rocky Mountain Section Meeting, Colorado Springs, Colo., Oct. 1964.

The role of the health physicist in the radiation safety program is reviewed. Qualifications of health physicists are discussed. A procedure for a radiation survey is outlined. (C.H.)

4400 (MND-3062-5) RE-ENTRY ABLATION EVALUATION OF SMALL MOLTEN DROPLETS OF STRONTIUM-90 SPACE FUEL. L. Sullivan, R. Burgio, and B. Clemenz (Martin-Marietta Corp. Aerospace Div., Baltimore). May 1964. Contract AT(30-1)-3062. 141p. Dep.(mn); $5.00 (cy), 3(mn) OTS.

A study was conducted of the effects of physical properties of possible nuclear space fuels on the ablation of small molten droplets of fuel which are entering the earth's atmosphere at hypersonic speeds. The objective is to identify the physical properties which control the rate of "burn-up" of small molten droplets and to specify the approximate values of these physical properties necessary to produce a prescribed total "burn-up." Ablation mechanisms were postulated and programmed for the IBM 7094 Computer. Preliminary results indicate that liquid viscosity, surface tension, heat of vaporization, and boiling point are the dominant physical properties. (auth)

4401 (ORNL-P-659) EFFECTS OF SHELL CORRECTIONS TO STOPPING POWER IN THEORETICAL DOSE STUDIES. J. E. Turner (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 15p. (CONF-803-2) Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Symposium on the Dosimetry of Irradiations from External Sources, Paris, Nov. 1964.

The theoretical evaluation of absorbed radiation dose in tissue from external sources is based on the absorbed energy and rate of linear energy transfer (LET) calculated from the Bethe stopping-power formula. For the chemical elements in tissue, it is known experimentally that shell corrections to the Bethe formula are needed for incident particle energies in the range 0 to 15 Mev. Shell correction curves that agree with experimental data for protons with a number of metals, ranging in atomic number from Be to Pb, have been developed. This work is applied to the light elements present in soft tissue. Shell correction curves, estimations of the mean excitation energies, and the results of several theoretical studies based on this work are presented. (auth)

4402 (RFP-437) PLUTONIUM NITRATE SHIPPING PACKAGES. F. E. Adcock, J. T. Byrne, R. L. Delnay, R. D. Gauthier, D. W. Park, and C. L. Schuske (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Oct. 16, 1964. Contract AT(29-1)-1106. 148p. Dep.; $4.00(cy), 3(mn) OTS.

Four packages have been designed, constructed, and tested to meet requirements of the AEC Manual Chapter 0529 which covers the regulations for shipping fissile material by common carrier. Two packages developed during this program meet the requirements for Class I shipments of plutonium nitrate. The Bureau of Explosives issued permit numbers 1799 and 1848 for the three-liter and ten-liter packages, respectively. Although a single shipment may contain an infinite number of these packages, Class I definition, physical limitations of vehicles set a practical limit on the numbers per shipment. For example, the weight of 100,000 pounds per boxcar limits the number of three liter packages to 177. A three-liter and a ten-liter package meet the requirements for Class II shipments. The Bureau of Explosives issued permit number 1857 and 1858. A criticality analysis indicates 322 three liter or 106 ten liter packages are safe for shipment. However, the calculated "radiation unit" limits these packages to 200 and 100 per shipment, respectively. Actual radiation measurements will set the number of packages per shipment if the dose rate in mr/hr exceeds the calculated "radiation unit." Estimated unit costs for shipment of 20 kilograms of plutonium from Buffalo, New York, to Denver, Colorado, range from $163/kg (Class II, 10 liters) to $427/kg (Class I, 3 liters). Containers and transportation expenses account for 25 to 50 percent of the total unit cost of shipping. It is suggested that unit costs can be reduced significantly for larger shipments. Proposed container designs up to 150 liter volume are discussed. (auth)

4403 (SC-DC-64-1572) OPERATION ROLLER COASTER MICROMETEOROLOGICAL MEASUREMENTS. H. W. Church (Sandia Corp., Albuquerque, N. Mex.) and D. M. C. Thomas (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). [Oct. 1964]. Contract [AT(29-1)-789]. 12p. (CONF-789-1) Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Meteorological Society National Conference on Micrometeorology, Salt Lake City, Oct. 1964.

A brief description is given of Operation Roller Coaster, a series of four experiments on the dispersion and scavenging of Pu and U from detonation of chemical explosives in nuclear weapons. The meteorological measurements program is discussed. Temperature profile, gustmeter, and cloud photography systems are described. (D.L.C.)

4404 (TLW-1092) ANALYSIS OF HIGH-ALTITUDE FILTER AND IMPACTOR MEDIA FOR EVALUATION OF PROPOSED SNAP REENTRY EXPERIMENT USING NON-RADIOACTIVE TRACER. Final Report. Walter D.

Holland, Chester E. Gleit, Philip A. Benson, Robert C. Wrigley, and Leon Leventhal (Tracerlab. Div. of Lab. for Electronics, Inc., Richmond, Calif.). Sept. 1964. Contract AF29(601)-5221. 155p. (WL-TDR-64-68)

An evaluation of the suitability of a variety of elemental tracers and filter media is presented. Quantitative data on the concentration of selected trace elements, obtained by neutron activation and radiochemical analysis, are given. Also included are the results of a high-altitude sampling program and an investigation into the use of impaction collectors. (auth)

4405 (ANL-Trans-126) LAWS OF TURBULENT GAS DIFFUSION AS A FOUNDATION FOR THE DETERMINATION OF MINIMUM CHIMNEY ELEVATIONS. Julius Drimmel, Heinz Fortak, Ernst Geisler, Guenther Hollmann, Werner Klug, Heinz Reuter, Hermann Stuemke, and Friedrich Wippermann. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from VDI (Vere. Deut. Ingr.)-Forschungsh., No. 483, 1-?(1961). 124p. Dep.(mn); $10.10(fs), $3.92(mf) JCL.

Factory chimneys in industrialized areas ought to have a certain minimum height which guarantees that the flue gas concentration on the ground does not exceed a definite limit still safe for human beings and plants. Methods to evaluate this minimum height are necessarily based on the laws of turbulent gas diffusion and governed by a series of meteorological parameters. Several investigations, independent of each other, were carried out in order to refine and improve the existing method based on the theory developed by O. G. Sutton. These refinements consist in taking into account the vertical elevation of the flue gases over the chimney mouth, the influence of the measuring time and of the time of immission, the variability of the stability of the atmosphere with height, an improved determination of the exponent in the Lagrangian correlation function, the extension of the method to low wind velocities, and the possibilities to evaluate the meteorological parameters entering the problem. (auth)

4406 CLEANING RADIOACTIVE PARTS. Donald L. Collins. Am. Machinist Metalworking Manuf., 108: 72-3 (July 20, 1964).

Ultrasonic cleaning of radioactive parts to remove radioactive particles was investigated. The technique uses a lead zirconate transducer to produce the required wattage for the cleaning operation. The operating principle and cleaning solutions are considered. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4407 BEHAVIOR OF AIRBORNE FISSION PRODUCTS. Luther B. Lockhart, Jr. (Naval Research Lab., Washington, D. C.). Am. Scientist, 52: 301-5(1964).

An account is given of some experimental results obtained from atmospheric measurements made from 1958 to 1962 by the 80th Meridian Air Sampling Program operated by the U. S. Naval Research Laboratory with the cooperation of various agencies and organizations in North and South America. The monthly averages of the burdens of gross β activity associated with particulate radioactive debris from bomb tests are presented graphically for the period 1958–1962. This period includes the nearly three-year moratorium on nuclear testing by the United States, United Kingdom, and Soviet Union occurring between two active periods of testing of large yield devices. The ^{90}Sr results show the strong influence of seasonal factors on radioactive fallout. The peaks are directly related to the greatly increased rate of downward mixing during the winter-spring season of stratospheric air rich in the long-lived fission products. Seasonal changes in rainfall rates, particularly in the tropical regions, influence the ^{90}Sr burdens only to a minor extent. In the Northern Hemisphere, the large quantities of ^{90}Sr found in the air at ground level in early 1959 resulted principally from tests held in the Soviet Union during the fall of 1958, with some contribution from the U. S. Pacific tests of 1958 and from earlier test series. That found during 1960 and 1961 was a mixture from many tests with no large proportion assignable to any particular test series. The fast rate of decrease between the maxima of 1959 and of 1960 is thus due primarily to the short residence time of debris injected into the polar region, and suggests an average residence time there of less than six months. A similar consideration of the 1960–1961 activity burdens leads to an estimated average life-time of nearly four years for the remaining stratospheric activity, primarily that resulting from injections in the tropical regions. In the Southern Hemisphere the seasonal variation was not well developed. The possible estimation of the rate of transequatorial movement of radioactivity within the stratosphere is discussed. (TCO)

4408 NATURAL RADIATION EMITTED BY THE HUMAN BODY. Ernesto Jibaja Torre Tagle. Bol. Junta Control Energia At. (Peru), 9: No. 48, 93-8(Jan.-Mar. 1964).

The natural radioactivity of the human body, 75 kg in weight, was calculated on the basis of the average chemical composition. (J.S.R.)

4409 APPLICATION OF ELECTROLYTIC POLISHING TO DECONTAMINATION OF MATERIALS CONTAMINATED BY RADIOACTIVE ELEMENTS. Pierre Cerre, Emile Mestre, and Jean de Kerdelleau. Bull. Inform. Sci. Tech. (Paris), No. 84: 37-45(June 1964). (In French)

The advantage of the electrolytic-polishing decontamination process in the case of metals, in particular stainless steel and aluminum, is shown. Operation conditions in a decontamination station using a phosphochromic bath at 50°C with a current density of 20 a/dm^2 are described. (auth)

4410 NUCLEAR ENERGY AND PROTECTION OF WATER. P. Bovard. Bull. Inform. Sci. Tech. (Paris), No. 84, 47-50(June 1964). (In French).

The increasing use of radioactive compounds is considered along with things being done to insure efficient protection, not only for men but also for the natural environment and in particular water. Care taken to remove radioactivity from effluents and to obtain the best conditions for emission is explained. Reasons for further checking in biosphere are discussed. (auth)

4411 PROTECTION OF WORKERS IN THE NUCLEAR INDUSTRY. R. Vial. Energie Nucl., 6: 305-12(July-Aug. 1964). (In French)

The security standards that determine the maximum permissible radiation doses were established by taking into account natural irradiation and the results of experiments on animals and observations on human beings. In order to insure the protection of the workers, it is necessary to be familiar with the hazards (external irradiation and internal and cutaneous contamination). The various means of protection are shields, remote control, ventilation, and exposure limitations. Rigorous monitoring and frequent controls and examinations make it possible to obtain completely satisfactory results. (tr-auth)

4412 PROCEEDINGS OF THE HANFORD SYMPOSIUM ON INHALED RADIOACTIVE PARTICLES AND GASES, RICHLAND, WASHINGTON 4-6 MAY, 1964. Karl Z. Morgan, ed. Health Phys., 10: 861-1259(Dec. 1964). (CONF-561)

Forty-four articles are included; separate abstracts were prepared for 39. One abstract on preparation of insoluble aerosols was not included in NSA. Four articles on modes of formation and properties of aerosol particles, Pu aerosol particle size distribution in room air, measurement of radioactive gas and dust in uranium mines in Japan, and factors affecting the design of a $^{14}CO_2$ nonrecirculating chronic inhalation apparatus for small animals were previously abstracted in NSA as 18: 29878, 33823, 35800, and 38772. (P.C.H.)

For abstracts of individual papers see: 3826, 3827, 3848, 3849, 3850, 3851, 3852, 3853, 3854, 3855, 3856, 3857, 3858, 3859, 3860, 3861, 3862, 3863, 3864, 3865, 3866, 3926, 4011, 4012, 4013, 4014, 4015, 4024, 4079, 4123, 4124, 4287, 4288, 4366, 4367, 4413, 4414, 4415, and 4416.

4413 SYMPOSIUM OF INHALED RADIOACTIVE PARTICLES AND GASES—STATEMENT ON THE PROBLEM. W. E. Lotz (Atomic Energy Commission, Washington, D. C.). Health Phys., 10: 863-6(Dec. 1964).

Potential hazards presented by the radioisotopes and fission products associated with the rapidly expanding aerospace nuclear power and propulsion programs presently under joint development by AEC, NASA, and DOD, such as SNAP and ROVER, are discussed. Safety considerations are included. (P.C.H.)

4414 STUDIES ON AIRBORNE RADIOACTIVE CONTAMINATION OF MINERS IN A YUGOSLAV URANIUM MINE. D. Djuric, M. Kilibarda, Lj. Novak, D. Panov, and M. Vukotic (Inst. of Occupational Health, Belgrade). Health Phys., 10: 1059-64(Dec. 1964).

For the last 4 years the radon concentrations in the atmosphere of a Yugoslav uranium mine have been measured periodically. The concentrations of ^{210}Po in the urine of miners was also determined. The potential sources of ^{210}Pb and ^{210}Po and the possibility of correlating radon exposure and polonium excretion in the urine are discussed. Certain assumptions lead to a very rough estimate of integral exposure of miners to radon. To elucidate one of the many problems encountered in a more detailed study of this correlation, a method for determination of ^{210}Po in the dust of the uranium mine was developed. Radium and uranium can be determined simultaneously with polonium. (auth)

4415 MONITORING OF SEVERAL INDIVIDUALS EXPOSED TO MIXED FISSION PRODUCTS GASES AT NTS. J. A. Eckert (Public Health Service, Las Vegas, Nev.). Health Phys., 10: 1123-27(Dec. 1964).

On June 6, 1963, several men working at the Nevada Test Site were accidentally exposed to fission product gases in a tunnel. The men were subsequently monitored using a 3 in. × 3 in. NaI collimated crystal and a multichannel analyzer. A phantom was constructed and the assembly was calibrated with several isotopes, the results being used in an extrapolation to find the efficiencies for ^{133}I and ^{135}I. Over 100 spectra were recorded, tracing the history of ^{131}I, ^{133}I, and ^{135}I from 8 hr after exposure to two weeks. Activity to dose conversion factors were developed for the various isotopes of iodine and dose estimates were calculated for the exposed individuals. These same dose conversion factors were applied to predicted iodine ratios from the fission of ^{235}U and an estimate of activity-dose conversion factor vs time of gas release was made. (auth)

4416 THE DISTRIBUTION AND DEPOSITION OF RADON DAUGHTERS ATTACHED TO DUST PARTICLES IN THE RESPIRATORY SYSTEM OF HUMANS EXPOSED TO URANIUM MINE ATMOSPHERES. H. E. Palmer, R. W. Perkins, and B. O. Stuart (General Electric Co., Richland, Wash.). Health Phys., 10: 1129-35(Dec. 1964). HW-SA-3506)

A mobile whole-body counting facility was used to study deposition of inhaled airborne particles with adsorbed radon daughters in human beings exposed in two uranium mines. Comparison of air samples with whole-body counting data obtained for 0.5–2.5 hr exposure in mines indicated nearly 100% deposition of radon daughters. The count median diameters of the airborne dusts were 0.1 and 0.2 μ and the mass median diameters were 0.3 and 0.7 μ in a non-operating mine, respectively. Longitudinal scans showed that 20% of total deposited radioactivity was in the head, 10% in the neck region, and 70% in the chest 15 min following exposure. There was little apparent translocation up to 2 hr after exposure. (auth)

4417 INDIVIDUAL PHOTOGRAPHIC DOSIMETRY SERVICE. P. Amadesi, G. Busuoli, A. Cavallini, and O. Rimondi (CNEN, Bologna). Minerva Nucl., 8: 258-69 (Sept.-Oct. 1964). (In Italian)

The film-badges used in gamma, x ray, and slow and fast neutron dosimetry are described, and the methods of calibration, the precision of the determinations, and their validity are indicated. Some statistical data regarding the number of films used and the values measured from 1959 to 1963 (first semester) are presented. (auth)

4418 ACTIVITY AND THYROID DOSE FROM RADIOIODINES. Ronald L. Kathren (Univ. of California, Livermore). Nucleonics, 22: No. 11, 60(Nov. 1964).

Equations are presented for determining maximum permissible concentrations for mixtures of gaseous fission iodines and thyroid doses following inhalation or ingestion. The method can also be used to determine the isotopic proportions of the various radioiodines from fallout in milk and other foods. (C.E.S.)

4419 DECONTAMINATION OF SURFACES OF MATERIALS CONTAMINATED BY RADIOISOTOPES. Maria Miazek-Kula. Prace Central. Inst. Ochrony Pracy, 11: 3-26(1961). (In Polish)

The removal of ^{32}P, ^{45}Ca, ^{60}Co, ^{90}Sr, ^{90}Y, and ^{134}Cs contamination from the surfaces of several materials was investigated. The materials included glass, plexiglas, vinidur, PVC foil, rubber for surgical gloves, linoleum, vinyleum, and coating of white oil-enamel. Aqueous solutions of the isotopes were used to contaminate the materials. After drying, the contaminated samples were decontaminated by chemical reagents. The degree of decontamination was studied as a function of period of decontamination, period of contamination, kind and concentration of decontaminating reagent, and method of decontamination. (P.C.H.)

4420 INVESTIGATION OF AN ELECTROFILTER FOR MONITORING THE RADIOACTIVE CONTAMINATION OF AIR. Jan Flattau. Prace Central. Inst. Ochrony Pracy, 14: 114-25(1964). (In Polish)

Measurements were carried out on the filtration effectiveness and the efficiency of collecting natural radioactive aerosols in the measuring electrofilter constructed according to the design of Shtukkenberg and others; this electrofilter is intended to be used in a monitor for radioactive aerosol contamination. Moreover, current tension-intensity ratio of the electrofilter was measured in order to check its conformity with the characteristic found by Shtukkenberg. With the air flow rate of 460 l per minute, the efficiency of collecting aerosols by means of the filter examined was (13 ± 2)%. (auth)

4421 EFFECT OF DETERGENTS ON THE DECONTAMINATION OF CERTAIN MATERIALS CONTAMINATED BY RADIOACTIVE STRONTIUM. Zbigniew Smal and Jadwiga Chmielewska. Prace Central Inst. Ochrony Pracy, 14: 126-33(1964). (In Polish)

Investigations were made on the effects of various kinds and various concentrations of detergents on the degree of decontaminating the following materials contaminated by radioactive strontium ^{90}Sr, PVC film, window glass (decontamination by rinsing), and acidproof steel Class 1H18N9T (decontamination by water and solutions of 0,1 and 1 n nitric acid and caustic soda). A positive effect was obtained by certain detergents on the degree of decontamination, this effect usually increasing with higher concentrations of the agents in solution. It was also found that an interdependence exists between the degree of decontamination and the concentration of nitric acid and caustic soda. (auth)

4422 EFFECT OF DETERGENTS ON THE DECONTAMINATION OF CERTAIN MATERIALS CONTAMINATED BY RADIOACTIVE ISOTOPES P^{32}, S^{35} AND J^{131}. Zbigniew Smal and Jadwiga Chmielewska. Prace Central Inst. Ochrony Pracy, 14: 134-49(1964). (In Polish)

An investigation was made on the effects of various kinds and concentrations of detergents (Sulfapol, Petepon G, Teepol, Merlafen 83, and Marlofen 812) on the degree of decontaminating PVC film, window glass, and acidproof steel Class 1H18N9T, respectively contaminated by radioactive isotopes ^{32}P, ^{35}S or ^{131}I. Distilled water, 1 n nitric and sulfuric acid, and caustic soda were used as decontamination agents. Decontamination was achieved by immersing the samples into 30 ml of the decontamination agent for 5 minutes. The results showed that the degree of decontamination depends on both the kind and concentration of the detergent used. (auth)

4423 INTERDEPENDENCE BETWEEN THE DEGREE OF DECONTAMINATION OF ACIDPROOF STEEL CONTAMINATED BY RADIOACTIVE COBALT, AND THE TYPE OF SURFACE OF THE STEEL. Maria Miazek-Kula. Prace Central. Inst. Ochrony Pracy, 14: 150-72(1964). (In Polish)

Investigations on the interdependence between the degree of decontamination of acidproof steel Class 1H18N9T contaminated by ^{60}Co, and the type of surface finish of the steel are discussed. The experiments were carried out using finished and unfinished steel samples by mechanical processes (grinding, polishing), and by chemical and electrochemical surface treatment. For decontaminating these samples, the following methods were applied: immersion in decontamination solutions, brushing by means of tampons soaked with decontaminating solutions. and anode and cathode electrodecontamination. It was determined that both the method and the agent used for decontamination bear on the relation between the degree of the effectiveness of the decontaminations of the contaminated surface and the type of the surface finish. Furthermore it came to light that, in many instances, changes in the finish of a contaminated surface brought about during the decontamination process, bear upon the results of further decontamination by the same method of the sample examined. (auth)

4424 RADIUM-226 AND POLONIUM-210 IN LEAF TOBACCO AND TOBACCO SOIL. T. C. Tso (Dept. of Agriculture, Beltsville, Md.), N. A. Halilden, and L. T. Alexander. Science, 146: 1043-5(Nov. 20, 1964).

Contents of radium-226 and polonium-210 in leaf tobacco and tobacco-growing soils were found to vary with the source. The differences may result from production locality, culture, and curing. The polonium seems to be not entirely derived from the radium, plants probably take it up from the soil or air. (auth)

4425 EXPERIMENTAL DECONTAMINATION OF MEDITERRANEAN MOLLUSCS CONTAMINATED BY RADIOACTIVATED WATER. P. Mauranges. Semaine Med. Profess. Med.-Soc., 40: No. 6, 110-11(1964).

The molluscan shell does not have any biological possibility to decontaminate itself after it has been made radioactive. It behaves exactly like the radioactive element by which it has been contaminated. Decontamination is completely identical with the activity curve of the isotope in question. If shells are accidentally contaminated by radioactive waste dumped into the sea they cannot be decontaminated by leaving them in unpolluted water. It seems, however, that they do not contaminate other shells. Therefore large quantities of shells contaminated accidentally can be kept in fresh water for a period exceeding the lifetime of the contaminant, but only if this is very short. (Excerpta Med., Sect. XXIII, (Oct. 1964))

4426 PLUTONIUM SHIPPING CONTAINERS (Engineering Materials). (Dow Chemical Co. Rocky Flats Plant, Denver). (CAPE-1170)

This package contains 34 drawings. For a listing of individual titles see the Engineering Materials List (TID-4100). These shipping containers are used to transport plutonium for power reactors and to eliminate discrepancies found in shipping and in receiving. The L-10 $Pu(NO_3)_4$ container consists of a 55-gal drum, which contains a stainless steel pressure chamber of 5.563-in. OD, 4.813-in. ID, and a height of 53 in. A polyethylene bottle of 4.665-in. ID and a height of 51 in. is used. The L-3 $Pu(NO_3)_4$ container consists of a 55-gal drum which encloses a stainless steel pressure chamber of 5.563-in. OD, 4.813-in. ID, and a height of 18.5 in. The polyethylene bottle is 4.740-in. ID and 16.8 in. in height. (F.S.)

4427 RADIOACTIVE STRONTIUM CONTAINMENT. Gerald B. Barton (to U. S. Atomic Energy Commission). U. S. Patent 3,161,600. Dec. 15, 1964.

A glass was developed containing from 30 to 60 wt % of SrO and from 33 to 65 wt % of P_2O_5, with or without SiO_2 (up to 2.5%), B_2O_3 (up to 4.5%), Al_2O_3 (up to 1%), MgO (up to 0.75%), and Na_2O (up to 2.5%). The prime purpose of the glass is for containment of ^{90}Sr for shipping purposes. The glass is water-insoluble but is soluble in hot strong acids. (AEC)

4428 RADIOACTIVE CESIUM CONTAINMENT. Gerald B. Barton (to U. S. Atomic Energy Commission). U. S. Patent 3,161,601. Dec. 15, 1964.

A process was developed for containing radioactive cesium in a $CsO-Al_2O_3-P_2O_5$ glass characterized by an addition of La(III) or Zr(IV) compound. Glasses consisting of 13 wt % Al_2O_3, 30 wt % P_2O_5, 12 wt % La_2O_3, or 15 wt % ZrO_2, with balance CsO, are also described. These glasses are water-insoluble, but soluble in hot strong acid. (AEC)

INSTRUMENTATION

General

Refer also to abstracts 4420, 4560, 4698, and 5528.

4429 (AF-TDR-64-167) AN X-BAND INTERFEROMETER. R. E. Pechacek (California. Univ., Berkeley. Electronics Research Lab.). Feb. 15, 1963. Contract AF33 (657)-7614. 26p. (AD-607664). $2.00 (OTS).

An interferometer for use in plasma diagnostics is described. A single klystron provides both the transmitter power and the local oscillator signal for a heterodyne receiver. The heterodyne receiver provides a greatly reduced noise figure, and the output signal is independent of the amplitude of the received signal. (auth)

4430 (HW-83458) AN ISOTOPE GAMMA SOURCE FOR CLAD THICKNESS MEASUREMENTS AND URANIUM CONTAMINATION DETECTION. R. B. Jacob (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 16p. Dep.; $1.00(cy), 1(mn) OTS.

Results of experiments performed in this investigation indicate that an iridium source should be as good if not better than the x-ray machine now in use for contamination testing. In addition, this source allows the measurement of zirconium cladding up to a thickness of about 0.1 in. The slope of the cladding thickness attenuation curve is approximately 400 counts/sec/0.001 in., which should allow the development of a very accurate cladding thickness tester or primary standard. (auth)

4431 (LNF-64/37) UN DISCRIMINATORE RAPIDO. (A Rapid Discriminator). Note No. 252. C. Dardini and G. Mazza (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 24, 1964. 10p. Dep.

The characteristics and properties of a transistorized rapid discriminator with resolution time <10 nsec are described. Its minimum threshold is 120 mv, and the duration of the output pulse is 5 nsec. (tr-auth)

4432 (UCRL-7952) AIRBORNE SCAN-CONVERTER SYSTEM. Stanley W. Thomas (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 13, 1964. Contract W-7405-eng-48. 27p. (CONF-799-4) Dep.(mn); $2.00(cy), 1(mn) OTS.

From 11th Annual Nuclear Science Symposium, Philadelphia, Oct. 1964.

A method of converting very high bandwidth, single-transient information in a rocket-borne experiment to a much lower bandwidth is described. Application of the scan conversion technique to single-transient information of nanosecond rise time permits conversion to bandwidths commensurate with present day telemetry systems. Signal-storage rise time capability is 1 to 10 nsec depending on the type of storage tube used. Of special interest is the unique transistorized linear sweep. Its delay between trigger and start of the sweep is less than 6 nsec and the sweep voltage is plus and minus 400 volts. Other transistorized circuitry, such as readout sweep, time base generator, and signal amplifier, is also discussed. (auth)

4433 (AEC-tr-6518(p.74-81)) AN INTERFEROMETRIC CIRCUIT WITH THE USE OF AN ELECTRON PHASE INVERTER FOR MEASURING FAST CHANGES IN PHASE IN THE MICROWAVE RANGE. D. K. Akulina and Yu. I. Nechaev. (Translation).

An interferometric circuit is described for measuring phase shifts of microwave signals allowed to pass through a plasma containing electron-density gradients. The circuit incorporates a phase inverter, which is a traveling-wave tube in which the central section of the spiral has been replaced by a drift tube. The spirals serve for introducing and amplifying the signal, and the drift tube plays the part of a regulated delay line. (R.E.U.)

4434 (AEC-tr-6518(p.82-90)) THE PASSAGE OF PHASE-MODULATED OSCILLATIONS THROUGH LINEAR SELECTIVE CIRCUITS AND THE ACCURACY OF QUICK-ACTING ELECTRONIC PHASE METERS. V. V. Khilil'. (Translation)

The effect of an amplification channel and other selective circuits of a phase meter, used for measuring rapid changes in electron concentration in a plasma, on the signal being received is discussed. The phase-modulated signal is obtained by passage of microwaves through a plasma. The output voltage of the phase meter is represented by a Fourier integral on the spectral density of the envelope of the input signal. The solution yields a series whose circle of convergence provides bounds for signal-distortion calculations. (R.E.U.)

4435 A SIMPLE APPARATUS FOR LONG-TERM RESPIRATORY CARBON-14 STUDIES IN RUMINANTS. E. N. Bergman (Cornell Univ., Ithaca, N. Y.). Am. J. Vet. Res., 25: 848-51(May 1964).

A simple respiratory apparatus designed for the continuous collection of exhaled $^{14}CO_2$ over prolonged periods is described and illustrated. A respiratory hood was made from a plastic tank so that the animal is not in total darkness and can be given small quantities of feed and water. A pump is used to aspirate CO_2-free air through the hood and to a gas-sampling meter. This meter measures total air flow and also diverts, and collects in a rubber bag, a known aliquot of the air stream. Only small volumes of air are collected for greater ease of analysis. It was found that sheep required only a minimum of training and little or no excitement or emotional stress could be detected. The results obtained during an experiment involving ^{14}C-acetoacetic acid metabolism in a pregnant sheep are exemplified. The total CO_2 exhaled by the sheep remained nearly constant at about 0.9 mols/hr (20 l/hr). The CO_2 gradually became labeled with ^{14}C and reached a nearly constant- or steady-state value after about 3 hr. In this type of experiment, the quantity of metabolite oxidized and its percentage of contribution to the total metabolic CO_2 can be calculated from the data obtained. This technique is superior to using a face mask or tracheal cannula since exertion or emotional stress cannot be tolerated in this type of metabolic experiment. The gas meter with aliquoting device obviates the awkwardness of collecting and analyzing large volumes of air or using large amounts of NaOH for absorption of CO_2. (BBB)

4436 TRANSMISSION OF PULSE-HEIGHT SPECTRA FROM BALLOON-BORNE EQUIPMENT TO GROUND STATIONS. C. Reppin (Universität, Kiel). Atomkernenergie, 9: 359-62(Sept.-Oct. 1964).

A system is described to record and transmit pulse heights from any device over a large dynamic range (200). To demonstrate its usefulness, the system was used in practice to transmit the pulse height spectrum created by ionizing cosmic radiation in a scintillator from a balloon to the ground station. (auth)

4437 UTILIZATION OF THE SNAP-OFF DIODE. R. Van Zurk (Commissariat à l'Énergie Atomique, Grenoble, France). Nucl. Instr. Methods, 31: 68-70(Dec. 1, 1964). (In French)

The possibility of using the snap-off diode without involving its bias in the reverse direction is pointed out. As application an improvement is shown of an amplitude discriminator circuit. (auth)

4438 A METHOD OF FAST DATA TRANSFER OVER TELEPHONE LINES. R. A. McNaught (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instr. Methods, 31: 106-8(Dec. 1, 1964).

A method of transmitting data in digital form over normal telephone lines is described. The data is accumulated on magnetic tape and then read into a computer, situated half a mile away, for sorting. (auth)

4439 FREE NUCLEAR INDUCTION APPARATUS FOR RELAXATION TIME MEASUREMENTS. A. Valeriu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 285-92(1964).

A free nuclear induction apparatus is described, which permits routine measurements of longitudinal relaxation times over 0.2 sec with an accuracy of 5%. The apparatus is equipped with an electric chronometer and an electronic peak voltmeter. (auth)

4440 MEASUREMENT OF INHOMOGENEOUS MAGNETIC FIELDS WITH THE NUCLEAR RESONANCE METHOD. Gerhard Fricke and Reiner Neuhausen (Technische Hochschule, Munich and Universität, Mainz). Z. Angew. Phys., 17: 446-8(Aug. 1964). (In German)

The nuclear resonance method can be used in field intensity measurements in inhomogeneous magnetic fields when the field gradient is compensated by a supplementary field in the range of the nuclear resonance probe. The construction of such a device was described in detail. The apparatus was used for field intensity measurements in a double-focusing magnetic spectrometer. (tr-auth)

4441 SPHERICAL ABERRATION OF A COMBINATION QUADRUPOLE LENS. A. D. Dymnikov, T. Ya. Fishkova, and S. Ya. Yavor (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1711-14(Sept. 1964). (In Russian)

Spherical aberrations were studied in a combined quadrupole lens that, at certain ratio between the superimposed electric and magnetic fields, possesses zero or negative chromatic aberration. (R.V.J.)

4442 LASER PUMP EMPLOYING THE PLASMA PINCH. R. H. Crompton, J. S. Hitt, and R. A. Williams (Philco Corp., Blue Bell, Penna.). 4p. (CONF-541-2).

From International Solid State Circuits Conference, Philadelphia, Feb. 1964.

A solid-state laser pump using the principle of the theta pinch is described, which provides pumping rate about 10^3 faster than conventional flash lamps. (D.C.W.)

4443 INVESTIGATIONS OF HIGH LUMINOSITY THETA PINCH DISCHARGES FOR LASER PUMPING APPLICATIONS. J. S. Hitt and J. M. Feldman (Carnegie Inst. of Tech., Pittsburgh). 10p. (CONF-637-7).

From Institute of Electrical and Electronics Engineers Region 3 Annual Meeting and Technical Conference, Clearwater, Fla., May 1964.

Modification of the theta pinch device to serve as an optical pump is described, together with the resultant pump. Electron temperatures and spectra of theta pinch discharges are included. The features of the pump are summarized. (D.C.W.)

4444 A SIMPLE MASS SPECTROMETER FOR ANALYSIS OF ARGON AT ULTRA-HIGH VACUUM. E. Farrar, R. M. MacIntyre, and Derek York (Univ. of Toronto). 9p. (CONF-649-15)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

A simple, inexpensive, leak-detecting device, the MS10, was examined to ascertain its value as a means of determining volumes of ^{40}Ar occupying less than 10^{-3} cc n.t.p. The instrument, which has a 2 in. radius of curvature and employs electrostatic scanning, is capable of routinely producing reliable measurements on such ^{40}Ar volumes, the isotopic dilution method being employed with ^{38}Ar as a tracer. Most notably there appears to be no memory effect. (auth)

4445 QUADRUPOLE MASS SPECTROMETER FOR ENERGETIC PARTICLE MEASUREMENTS. L. G. Hall and M. R. Ruecker (Consolidated Systems Corp., Monrovia, Calif.). 23p. (CONF-649-19)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

Analytical expressions were developed that define the initial conditions for 100% transmission of a quadrupole analyzer and that enable combination with equations for the focal properties of an ion source. The equation for the combined properties can be used to calculate the ion current intensity of the system as a function of the gas density, parameters of the mass spectrometer, and upper limits of acceptance of initial energy and initial angle. It is shown that the measurement of density is, in principle, independent of the initial energy and initial angle at the time of ionization within the established upper limits. The equations are particularly useful in design of instruments for measurement in the upper atmosphere. (auth)

4446 SUPERVISORY APPARATUS FOR DETECTING DAMAGED TUBE SYSTEMS IN FORCED-FLOW STEAM GENERATORS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 969,176. Sept. 9, 1964. Priority date Apr. 26, 1962, Germany.

An apparatus is designed for locating and disconnecting a defective tube system in forced-flow steam generators subdivided into a plurality of parallel-connected tube systems. The apparatus comprises a plurality of electric circuits, each being associated with a particular system and having means for producing an electric potential proportional to pressure or flow rate. Limit value switches can be coupled with the measuring instruments for giving a warning signal and for disconnecting the defective tube system. (D.L.C.)

4447 IMPROVEMENTS IN OR RELATING TO REPETITIVE HYDROGEN-ISOTOPE DISPENSERS FOR NEUTRON GENERATORS. Reuben Redstone and Donald Sutherland Stark (to United Kingdom Atomic Energy Authority). British Patent 974,409. Nov. 4, 1964. Filed Aug. 30, 1960.

An arrangement is described whereby H_2 or H_2 isotopes can be dispensed in a sealed space such as a neutron source. A vanadium piece with occluded H_2 is sealed in the apparatus, and the H_2 is released as heat is applied. (T.R.H.)

4448 IMPROVEMENTS IN OR RELATING TO VALVES FOR CONTROLLING FLUID FLOW. Ralph James Harte and John Llewellyn Williams (to United Kingdom Atomic Energy Authority). British Patent 974,664. Nov. 11, 1964. Filed May 26, 1961.

A remote-operated valve for controlling fluid flow rates of the order of 0.01 μl/sec is described for mass spectrometers. The valve operates through a lever attached to a thermal expansion rod. (T.R.H.)

Radiation Detection

Refer also to abstracts 4028, 4080, 4199, 4863, 5160, and 5545.

4449 (ANL-6920) A MULTIPURPOSE NEUTRON DIFFRACTOMETER. Masao Atoji (Argonne National Lab., Ill.). July 1964. Contract W-31-109-eng-38. 119p. Dep.; $4.00(cy), 2(mn) OTS.

The most unique application of neutron diffraction is in the study of the scattering phenomena due to interaction between the neutron magnetic moment and the magnetic moment of the atom, since neither x-ray nor electron diffraction can furnish information regarding the electronic spin structure. Crystal structure analysis is frequently a necessary preliminary to the magnetic study. Because of the scattering-amplitude characteristics, the neutron-diffraction technique has often played more than just a complementary role to x-ray and electron methods. For pursuing these two major subjects, an automatic double-crystal neutron diffractometer, designed for both crystal and magnetic structure analyses at temperatures from 2 to approximately 2000°K, and with a magnetic field of up to 18 kGauss for a 1.4-in. gap, was constructed at the CP-5 reactor. The diffractometer is primarily intended for study of thermal-neutron elastic scattering by poly- and single-crystal substances. Limited studies of the inelastic scattering, the total and related cross sections, and the small-angle scattering can also be accomplished. Nonpolarized beams of neutrons are used. Incorporation of the polarized-

beam technique, on the other hand, would require some alterations of the beam-guide components and additional electronic control systems. The engineering design was started late in 1960, and construction of the diffractometer was commenced early in 1961. The basic diffractometer components were assembled in mid-1962, and the first diffraction pattern was obtained through manual operation in June 1962. The electronic units for the four-angle automatic operation were tested in late 1962. At about this time the high- and low-temperature instruments designed primarily for the crystallographic studies were completed. The electromagnet unit equipped for operation at high and low temperatures became operational in mid-1963. At the same time that diffraction experiments were being carried out, some improvements of various components were made during 1963 to 1964. Besides outlining construction and instrumentation of our neutron diffractometer and its auxiliary equipments, the report includes a critical evaluation on the unit, the experimental results representing the instrumental characteristics, and tables, diagrams, and formulas useful for practical neutron studies. A list of selected reference books and review articles is given. (auth)

4450 (CEA-R-2560) MESURE CONTINUE DES FLUX DE NEUTRONS A L'AIDE D'UN DISPOSITIF CONVERTISSEUR. (Continuous Measurement of Neutron Flux With the Aid of a Converter Device). Pierre Mas and Paul Sciers (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1964. 20p. Dep. (mn).

An element, the thermal neutron activation product of which has a short period and is a β-particle emitter, is surrounded by a dielectric which is itself surrounded by a conducting metal. β particles are stopped in the conducting metal. Thus an electric current rises between the emitter element and the collector metal. The experimental study was done with rhodium as emitter. The linearity as a function of thermal flux of the power of the pile, the accuracy, the efficiency of the device were measured and are satisfactory. The stability of the equipment is not very good. This method gives the instantaneous flux and the integrated flux and is adapted for measurements in pile and in loops. (auth)

4451 (CERN-64-44) ORGANIZATION OF TRIGGERED WIRE SPARK CHAMBERS. F. Krienen (European Organization for Nuclear Research, Geneva). Oct. 23, 1964. 14p. Dep.(mn).

The principle of arranging all ferrite cores, regardless of the geometry or size of the spark chambers, in one large matrix with the objective of reaching the shortest word length and the shortest read-out time is proposed. The organization of the read-out system fulfilling this principle is described. A distinction is made between home-made wire spark chambers and those requiring a long-term project, with special emphasis on multi-ton wire spark chambers. (auth)

4452 (DP-921) A HIGH-LEVEL GAMMA ALARM FOR CRITICALITY MONITORING. Louis H. Cook, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1964. Contract AT(07-2)-1. 15p. Dep.; $1.00 (cy), 1(mn) OTS.

A monitor was developed that detects the gamma radiation from a nuclear accident and gives visible and audible alarms when the radiation exceeds a predetermined level. The instrument also gives a failure alarm when certain common internal malfunctions occur. Auxiliary alarm contacts are available for use with external alarm systems. The instrument is battery powered and, consequently, is unaffected by short-term power outages. A charger maintains the alarm battery at full power. (auth)

4453 (HW-81338) BETA ESCAPE EFFICIENCY FROM A CYLINDRICAL SOURCE. L. D. Philipp (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 20, 1964. Contract AT(45-1)-1350. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The purpose of this report is to calculate the escape efficiency of beta particles from a cylindrical source. The work was carried out to determine the projected efficiency for a beta-current type of reactor in-core neutron flux detector containing an isotope which beta decays subsequent to neutron capture. The betas emitted are monitored as current, and this provides an indication of neutron flux. Physically, a cylindrical source surrounded by a concentric collector provides a model for the neutron flux monitor. Due to the self-absorption of the cylinder, not all the betas generated will escape, and for calibration of the device, it is necessary to determine the efficiency of collection of the betas. The method employed is described, and it is noted that the method may be applicable to the solution of related problems. (auth)

4454 (HW-81486) THE U-235 FUEL ENRICHMENT MONITOR. J. L. Stringer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1, 1964. Contract AT(45-1)-1350. 24p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

An instrumentation system was developed to measure the ratio of U-235 to U-238 in metal samples. The measurement technique is based on a normalized count of the 185-kev gamma activity of U-235. Measurement accuracies on the order of better than two per cent can be achieved with the system. (auth)

4455 (HW-84398) THERMOLUMINESCENT DOSIMETRY SYSTEM. Status Report. R. W. Hardie and G. W. R. Endres (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 2, 1964. Contract AT(45-1)-1350. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The lithium-fluoride phosphor shows promising capability as a gamma and x-ray dosimeter. The sensitivity was adequate to detect a minimum radiation dose of 20 mR for 50 mg of phosphor. Low energy x-ray exposures (~20 kev) show the response to increase only about 20% above the response at high energy (~1 Mev), thus, for many purposes, the dosimeter has a satisfactory flat energy response. Phosphors supplied by two manufacturers were tested. Results of the tests showed that the sensitivity of these phosphors varied by as much as a factor of two between manufacturers and also between batches of phosphor from the same manufacturer. The dosimetry properties are a sensitive function of the impurities added to the phosphor and the manufacturing processes used in preparing the sensitized phosphor. Tests also showed that 50 mg samples yield the most light output per mg of phosphor for the thermoluminescent reader and geometry used. In a series of stability measurements, dosimeters exposed to 300 mR were read at various times from one day to fifteen days after exposure. After fifteen days, the light output per unit radiation dose had decreased only 5% from the light output after one day. Two capsules filled with LiF are required for a neutron dosimeter. The LiF in one of the capsules is surrounded by a hydrogenous material. The minimum sensitivity of the neutron dosimeters tested is about 1 Rem. At this exposure, the detection probability is about 50%. Properties of several hydrogenous materials were investigated in an attempt to increase the neutron sensitivity of the system. (auth)

4456 (IDO-17015) A LINEAR LEAST-SQUARES FITTING PROGRAM FOR THE ANALYSIS OF GAMMA-RAY SPECTRA INCLUDING A GAIN-SHIFT ROUTINE. R. G. Helmer, R. L. Heath, D. D. Metcalf, and G. A. Cazier (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 1964. Contract AT(10-1)-205. 58p. Dep.; $3.00(cy), 1(mn) OTS.

A computer program is described which is intended for use in the analysis of complex gamma-ray spectra obtained with scintillation spectrometers. Given a composite spectrum and a set of up to 25 component spectra, the program determines the intensities of these components in the composite by carrying out a linear, least-squares fit. Several options are available to adapt the program to spectral analysis. These include the ability to subtract backgrounds, fix the intensities of selected components, fix the relative intensity of any two components, reject negative intensities, vary the number of data points used in the fit, and use different weighting functions.

In order to correct for drift in the electronic system, the gain of the spectra may be changed by a gain-shift subroutine. Cycling options are available to expedite the processing of large numbers of composite spectra. Results of four problems are discussed to illustrate the use of the program. Input formats are given along with a sample output listing. Complete FORTRAN listings are included for versions used on IBM-7040 and 7094 computers. (auth)

4457 (ISS-64/20) SULL'USO DEL DIFFRATTOMETRO LINEARE HILGER & WATTS IN CASO DI ESTINZIONI SISTEMATICHE. (Systematic Absences and a Modification of the Hilger & Watts Linear Diffractometer). M. Colapietro and L. Zambonelli (Italy. Istituto Superiore di Sanità Rome). June 10, 1964. 24p. Dep. (mn).

The purpose of the report is to describe a modification of the Hilger and Watts linear diffractometer. This modification enables one to program the relative positioning of the crystal and the counter both in the standard way and in such a way as to avoid the points of the reciprocal lattice where the intensity of the reflection is zero because of systematic absences. An outline of the systematic absences phenomenon and a short description of the Hilger and Watts linear diffractometer are also given. (auth)

4458 (ISS-64/23) SULLA DISCRIMINAZIONE TRA DIVERSI TIPI DI PARTICELLE IONIZZANTI MEDIANTE L'ANALISI DELLA FORMA DELL'IMPULSO DI SCINTILLAZIONE. (Pulse Shape Discrimination of Ionizing Particles With Scintillation Counters). M. Grandolfo (Italy. Istituto Superiore di Sanità, Rome). June 15, 1964. 49p. Dep.(mn).

In recent years much research has been carried out on discrimination of particles of different specific ionization. An analytical study of one pulse-shape discrimination method is presented. This is followed by a numerical computation carried out with a 7040 IBM computer. A comparison is presented between numerical and experimental results for a Trans-Stilbene crystal for α- and γ-ray bombardment. (auth)

4459 (ISS-64/30) PRECISION MEASUREMENT WITH THE FREE-AIR IONIZATION CHAMBER OF THE ISTITUTO SUPERIORE DI SANITA. A. L. Bartoli and G. Missoni (Italy. Istituto Superiore di Sanita, Rome). July 15, 1964. 14p. Dep.(mn).

The errors arising in the measurement of exposure dose with a free-air ionization chamber are briefly reviewed. The correction factors obtained from tests and measurements with the standard chamber designed and built in the Physics Laboratory are reported. (auth)

4460 (JÜL-187-RX) EINRICHTUNG EINER β-γ-KOINZIDENZAPPARATUR ZUR ABSOLUTBESTIMMUNG RADIOAKTIVER QUELLSTARKEN (SPEZIELL ANGEWANDT AUF AKTIVIERTE GOLDFOLIEN). (Arrangement of a β-γ Coincidence Apparatus for Absolute Determination of Radioactive Source Strength (Special Application to Activated Gold Foils)). W. Schneider (Kernforschungsanlage. Institut Reaktorexperimente, Jülich, Germany). Mar. 1964. 37p. Dep.(mn)

The arrangement, suitability, and control measurements with a β-γ coincidence apparatus, which will serve for absolute determination of ^{198}Au radioactivity in gold foils (20 μ thick, $\leq$1cm^2 circular surface), are described. On the basis of the measurements obtained, the absolute determination of neutron flux, as well as the power calibration in the startup program of the FRJ-2, were carried out. The activity measurement region for the target samples ranged from 0.002 to 1 μC; the error in measurement amounted to approximately $\pm$2% under good conditions. (tr-auth)

4461 (LNF-64/39) UN CIRCUITO DI TRIGGER PER SPARK-GAP. (A Trigger Circuit for Spark-Gap). Note No. 254. M. Fascetti and A. Massarotti (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 25, 1964. 4p. Dep.

The design and characteristics of a trigger circuit suitable for spark gaps that feed a spark chamber is described. It is especially suitable because of the delay (~31 nsec) between input and output and the inappreciable jitter (<1 nsec). (J.S.R.)

4462 (LNF-64/40) CONVERTITORE DIGITALE ANALOGICO FLESSIBILE PER IL CONTROLLO DI ESPERIENZE "ON LINE". (Flexible Analog Digital Converter for the Control of "On Line" Experiment). Note No. 255. B. Bertolucci and M. Coli (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 27, 1964. 13p. Dep.

A circuit was designed that, given a codified situation in input, yields in output a square pulse whose duration is proportional to the number input according to a conversion time base. By operating on such a time base, coupled to an external oscillator, the converter has a digital output in any code. The principle of the circuit is described. The analysis time was determined, and the input circuit was given. Possibilities for the use of the circuit in the control of on-line experiments were illustrated. (J.S.R.)

4463 (NP-14356) METODY ETALONIROVANIYA RADIOAKTIVNYKH ISTOCHINKOV I GRADUIROVKI RADIOMETRICHESKOI I DOZIMETRICHESKOI APPARATURY. (Radioactive Source Calibration and Graduation of Radiometric and Dosimetric Instruments). S. N. Baikalov, R. D. Vasil'ev, E. F. Garapov, et al. (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispo-'zovaniyu Atomnoi Energii). [1963]. 18p. Dep.(mn).

The All-Union D. I. Mendeleev Institute for Metrology is assigned the duty of developing standard measurements for ionizing radiations, including the determination of the activity, dose, energy spectrum, decay scheme, particle yield, and other characteristics of radioactive sources and fields. Prototype and operational radiation sources and spectrometric instruments are systematically examined at the Institute where also basic methods are developed for measuring the dose and the dose rate of x and γ radiation sources. Currently, attention is devoted to the development of standard methods for measuring the flux density, energy spectrum and angular distribution of thermal neutrons. Monoenergetic neutron sources, such as those based on (d,d) and (γ,n) reactions are investigated. Standard sources are prepared by depositing the radioactive material on a stainless steel or Al support at a thickness of about 100 μg. During the first stage of the study, natural U, ^{239}Pu, ^{60}Co, ^{90}Sr + ^{90}Y, and ^{204}Ta were used as the chief emitters. Spherical, 40 and 25-mm Ra-γ-Be sources were used as reference standard for the neutron flux density measurements; for the calibration of thermal neutron sources, a paraffin block containing a Po-α-Be, Pu-α-Be, Ac-α-Be, or Ra-α-Be source in its center was employed. The current metrological studies carried out at the Institute are described. (TTT)

4464 (NP-14357) APPARATURA DLYA RADIOMETRII GAZOVYKH I ZHIDKIKH SRED. (Instruments for Radiometry in Gaseous and Liquid Media). M. N. Pchel'nikov, K. P. Markov, and N. N. Bykovskii (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). [1963]. 19p. Dep.(mn).

A review is given of devices for monitoring radioactive aerosols and water. (R.V.J.)

4465 (NP-14358) IZMERENIE MOSHCHNOSTI DOZY NEITRONNOGO IZLUCHENIYA SHIROKOGO ENERGETICHESKOGO SPEKTRA. (Measurement of Neutron Radiation Dose With a Wide-Range-Energy Spectrum). N. A. Golovanov, N. M. Kozodaeva, B. A. Korotin, and G. K. Popkov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). [1962]. 10p. Dep.(mn).

An ideal instrument for measuring the dose rate should possess an energy response which is inversely proportional to the energy of the maximum permissible flux. The currently available apparatus do not possess such a correlation and therefore may give erroneous measurements. Two methods are used for carrying measurements in the broad range from 0.025 ev to 20 Mev; they are based on the use of a known thickness of a moderator and on the known energy dependence of the sensitivity of scintillation detectors. The true dosimetric curve may be satisfactorily approached

by employing certain given relationships between epithermal and fast-neutron detectors in a system. The dispersion-type scintillation counters present the advantage of a very small diameter. The ZnS(Ag) + Plexiglas type fast-neutron counters may be rendered sensitive with respect to epithermal and thermal neutrons by the introduction of Li tetraborate, but their dosimetric characteristics are not satisfactory. Separate counters may be employed instead of the isodose systems; they are easier to build, calibrate, and operate. Construction of stationary and portable instrument systems is described. (TTT)

4466 (PAN-525/VIII) STATYSTYKA POMIARÓW AKTYWINOŚCI. (Statistics of Radioactivity Measurements). Andrzej Rokosz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1964. 21p. Dep.

Methods of determination of the statistical error in radioactivity measurements have been discussed. Numerous examples illustrate practical applications of the derived formulas to planning the conditions of a measurement, as well as to its subsequent interpretation. (auth)

4467 (TID-7705) SYMPOSIUM ON CRYSTAL DIFFRACTION OF NUCLEAR GAMMA RAYS, NATIONAL TECHNICAL UNIVERSITY, ATHENS, JUNE 15-17, 1964. Felix Boehm (California Inst. of Tech., Pasadena). Contract AT(04-3)-41. 315p. (CONF-614). Dep.(mn); $7.00 (cy), 6(mn) OTS. (In English and French)

Separate abstracts were prepared for 19 of the 21 papers included; one was previously abstracted in NSA (18: 32268), and the remaining paper is on the installation of a curved-crystal spectrometer at the Univ. of Colorado. (R.E.U.)

For abstracts of individual papers see: 4468, 4469, 4470, 4471, 4472, 4473, 4474, 4475, 4476, 4477, 4478, 4479, 4480, 4481, 4482, 4483, 4827, 4828, and 5134.

4468 (TID-7705(p.9-34)) THE ARGONNE 7.7-m SPECTROMETER. R. K. Smither (Argonne National Lab., Ill.).

The Argonne 7.7-meter bent-crystal spectrometer is described. The current research program and the spectrometer precision for energy level studies of heavy nuclei from thermal neutron-capture gamma spectra are discussed. Some results are given. (R.E.U.)

4469 (TID-7705(p.35-49)) SOME INVESTIGATIONS OF FLAT GERMANIUM SINGLE CRYSTALS. B. Lundqvist, S. Nilsson, and S. Silven (Chalmers Tekniska Högskola, Göteborg).

Some properties of quartz, germanium, copper, and gold crystals for use in bent-crystal gamma spectrometers are discussed. Crystal growth and dislocation densities are considered. (R.E.U.)

4470 (TID-7705(p.50-64)) A FOUR METER BENT CRYSTAL SPECTROMETER. B. Lundqvist, J. Rohlin, S. Nilsson, and R. Hardell (Chalmers Tekniska Högskola, Göteborg).

A line-source diffraction spectrometer was built for analysis of gamma rays from fission products in irradiated reactor fuel elements. The detector is a 4×4 in.^{2} NaI(Tl) scintillator. (R.E.U.)

4471 (TID-7705(p.65-73)) CURVED CRYSTAL SPECTROMETER FOR THE MEASUREMENT OF NEUTRON CAPTURE GAMMA RAYS AT RISÖ. O. W. B. Schult, U. Gruber, B. P. Maier, and R. Koch (Munich. Technische Hochschule and Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø).

A curved-crystal spectrometer for peripheral use with the DR-3 reactor at Risø is described. A 4-mm thick quartz lamina is used to detect the low-energy neutron capture gamma rays. (R.E.U.)

4472 (TID-7705(p.74-91)) A DOUBLE-FLAT-CRYSTAL SPECTROMETER FOR (n,γ) STUDIES. S. Nilsson, B. Lundqvist, and R. Hardell (Chalmers Tekniska Högskola, Göteborg).

The design and performance of a double-flat-crystal spectrometer for precision angular measurements of neutron-capture gamma rays are described. (R.E.U.)

4473 (TID-7705(p.92-112)) DESCRIPTION OF THE MOL-SPECTROMETER DIFFRACTION OF GAMMA RAYS BY A BENT QUARTZ CRYSTAL IN THE CAUCHOIS-TYPE ARRANGEMENT. P. van Assche (Centre d'Étude l'Énergie Nucléaire, Mol, Belgium).

A bent-quartz-crystal spectrometer in a Cauchois-type arrangement is described that is to be used in level structure studies for the rare earth elements and for neutron-capture studies associated with the BR-2 reactor. Nuclear emulsions (Ilford G-5) are used as detectors in the arrangement. (R.E.U.)

4474 (TID-7705(p.113-23)) THE CURVED-CRYSTAL SPECTROMETER AT THE UNIVERSITY OF MICHIGAN. James J. Reidy, A. B. Miller, and M. L. Wiedenbeck (Michigan. Univ., Ann Arbor).

A precision curved-crystal spectrometer, following the design of Seppi, Henrickson, Boehm, and Dumond, has been built and put in operation. The use of a tantalum collimator and germanium crystals has effectively extended the range of the instrument beyond 2 Mev. Results are presented concerning four crystals; quartz(310), quartz(112), Ge(400), and Ge(022). In addition, measurements of the energies of gamma rays are presented for ^{46}Sc, ^{56}Mn, ^{116}In, and ^{187}W. (auth)

4475 (TID-7705(p.124-39)) THE 2-m BENT GERMANIUM CRYSTAL SPECTROMETER IN PASADENA AND THE MOSAIC AND REFLECTION PROPERTIES OF THE GERMANIUM CRYSTALS. F. Boehm (California Inst. of Tech., Pasadena). (CALT-63-6)

A curved-crystal spectrometer of Dumond geometry used as a source of monochromatic radiation for x-ray excitation of nuclear states is described. The instrument uses a Ge(400) crystal and stationary source with movable collimator. The reflection power of curved crystals of quartz (310) and germanium (400) and (422) was studied as a function of energy using a ^{182,183}Ta source. (R.E.U.)

4476 (TID-7705(p.140-53)) THE LINEAR-MOTION, BENT-CRYSTAL SPECTROMETER AT UTAH STATE UNIVERSITY. W. F. Edwards and O. H. Otteson (Utah State Univ., Logan).

The bent-crystal spectrometer under construction utilizes a crystal that moves in translation perpendicular to a stationary line joining the radiation source and fixed detector. A lead block shields the detector from the direct beam. Analysis shows that this low-cost spectrometer will have improved luminosity below 0.65 Mev and improved diffracted line-to-background intensity ratio well above 1 Mev. The instrument can be operated with different focal circle radii. (auth)

4477 (TID-7705(p.154-62)) PRODUCTION OF SINGLE CRYSTALS WITH PREDETERMINED ORIENTATION OF THE ATOMIC PLANES. N. Ryde, S. Floberg, and C.-A. Cardell (Chalmers Tekniska Högskola, Göteborg).

The "strain-anneal" method for growing metallic single crystals for use in gamma spectroscopy was studied. The production of aluminum single crystals for a double-flat-crystal spectrometer is described. (R.E.U.)

4478 (TID-7705(p.175-93)) SUR L'EFFET INSTRUMENTAL DANS LA SPECTROSCOPIE PAR CRISTAUX COURBES. ESSAI DE CORRECTION DES LARGEURS. (On the Instrumental Effect in Spectroscopy by Curved Crystals. Test for Correction for Widths). Yvette Cauchois (Paris. Université).

Diffraction line broadening due to curved crystals used in gamma and x-ray spectroscopy is discussed. Corrections factors for measured values are developed. (R.E.U.)

4479 (TID-7705(p.214-30)) MÖSSBAUER EFFECT AND CRYSTAL DIFFRACTION. E. Kankeleit (California Inst. of Tech., Pasadena). (CALT-63-9)

The use of a crystal spectrometer in Mössbauer effect studies is discussed. A flat-crystal spectrometer was used to determine the total conversion coefficient for the first excited level in ^{169}Tm. (R.E.U.)

4480 (TID-7705(p.240-54)) π MESIC X-RAY MEASUREMENTS AT THE 184" CYCLOTRON IN BERKELEY. A. Astbury (Gt. Brit. National Inst. for Research in Nu-

clear Science, Harwell, Berks, England); K. M. Crowe, R. E. Shafer (California. Univ., Berkeley. Lawrence Radiation Lab.); and R. E. Taylor (Stanford Univ., Calif. Stanford Linear Accelerator Center).

The use of a bent-crystal spectrometer in the study of π mesic x rays is described. (R.E.U.)

4481 (TID-7705(p.265-87)) INTENSITY MEASUREMENTS WITH A BENT-CRYSTAL SPECTROMETER. R. Hardell, J. Rohlin, and S. Nilsson (Chalmers Tekniska Högskola, Göteborg).

A 1-m quartz (310) bent-crystal spectrometer for burnup analysis of irradiated fuel elements was used in a study of energy dependence of crystal reflectivity. (R.E.U.)

4482 (TID-7705(p.288-93)) NEUTRON-CAPTURE GAMMA-RAY WORK IN RISÖ. O. W. B. Schult, U. Gruber, B. P. Maier, and R. Koch (Munich. Technische Hochschule and Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø).

Some operational results are reported for neutron-capture gamma spectra measurements using the Risø spectrometer. (R.E.U.)

4483 (TID-7705(p.294-313)) ENERGY CALIBRATION PROBLEMS IN A CAUCHOIS-SPECTROGRAPH. P. van Assche (Centre d'Etude l'Énergie Nucléaire, Mol, Belgium).

Calibration procedures and results for a Cauchois-type curved-crystal spectrometer are given. (R.E.U.)

4484 (UCRL-11613) DEVELOPMENT, TESTING, AND CALIBRATION OF THE LRL THERMOLUMINESCENT DOSIMETRY SYSTEM. Francis M. Miller and Lowell M. Kleppe (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 24, 1964. Contract W-7405-eng-48. 16p. Dep.; $1.00(cy), 1(mn) OTS.

The LRL lithium fluoride thermoluminescent dosimetry system is capable of measuring doses of gamma radiation from 10 mR to more than 30,000 R. Calibration curves were obtained for gamma radiation from cobalt and radium, x rays of 100 and 250 kv, high-energy protons and alpha particles, and for both 5-Mev and thermal neutrons. The problem of reducing variations in the photomultiplier dark-current magnitude and increasing the over-all stability of the system was solved by use of an infrared filter, the standardization of the operating procedure, and the cooling of the face of the PM tube with room-temperature dry-nitrogen gas. The LiF dosimeter is currently being used in a variety of biomedical applications, some of which relate to cancer research and space medicine. Another application is in determining the field pattern of x-ray machines. In the future, personnel monitoring will undoubtedly utilize this dosimeter. The readout system is being used to study shock- and strain-induced thermoluminescence in $CaCO_3$ (limestone). (auth)

4485 (UCRL-11638) DATA HANDLING IN EMULSION EXPERIMENTS. Walter H. Barkas (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 27, 1964. Contract W-7405-eng-48. 6p. (CONF-787-1) Dep. (mn); $1.00(cy), 1(mn) OTS.

From 5th International Conference on Nuclear Photography, Geneva, Sept. 1964.

Procedure requisite to nuclear emulsion experiments is described. The scan-planning and subsequent measurements are discussed. Preparation of data for computing machines is considered. (R.E.U.)

4486 (AEC-tr-6227/2(p.113-29)) SOME EXPERIENCE WITH THE THREE CRYSTAL NEUTRON SPECTROMETER. Z. Dimitrijevic, Sz. Krasnicki, R. Maglic, V. Markovic, and J. Todorovic. Translated from Bull. Boris Kidrich Inst. Nucl. Sci., 15: No. 2, 113-29(1964).

Methods used during setting up of the three crystal neutron spectrometer are described. Some monocrystals were investigated from the point of view of their usefulness as monochromators and analyzers of thermal neutron energy. Al monocrystals gave nonmonotonic intensity distribution within the reflected beam, which can be explained by the so-called linear structure. With a Ge (111) monocrystal, the thermal neutron spectrum from horizontal beam hole "A" of the heavy water moderated RA reactor at Vinča was measured. (auth)

4487 (AEC-tr-6518(p.39-45)) A NEW METHOD OF ENERGY CALIBRATION OF VACUUM SPECTRAL INSTRUMENTS. V. I. Gladushchak, Yu. P. Kanevskii, and E. Ya. Shreider. (Translation)

The graduation method proposed is suitable for the graduation of monochromators as well as spectrographs. It is pointed out that prior calibration of the spectral instrument is more practical than the use of a standard comparison source, which in the vacuum region of the spectrum would have to be a synchrotron, which in turn entails noticeable experimental difficulties. The calibration is by recording on the vacuum spectral instrument the radiation from a source in which the ratio of the spectral-line intensity can be determined from measurements in the visible region of the spectrum and from the calculated transition probabilities. The theory of such a method is described briefly and its errors are analyzed. The method was used to calibrate a normal-incidence spectrograph (SP-99, grating with 2-meter radius and 1200 lines per mm, linear dispersion 4.1 Å/mm). The light source was a low-voltage vacuum spark. By recording the spectrum of the vacuum spectrograph on film and comparing the calculated intensity ratios with the experimental ones, it was possible to determine a coefficient characterizing the transmission of the instrument and the quantum yield of the material employed. The tests were made against 12 lines of Al III. The Al III and Si IV lines were used for the calibration, and the transition probabilities for these lines was calculated from the tables of Bates and Damgaard. The radiation of the spark was simultaneously photographed on a quartz spectrograph (ISP-28) and on the calibrated instrument, and the intensities of the spectral lines were measured. The intensity ratios of the Al III lines were calculated from the known transition probabilities and the temperature measured with the ISP-28. Several versions of the measurement technique are also described. (JPRS)

4488 (AEC-tr-6518(p.46-58)) SENSITIVITY OF AN ELECTRON-OPTICAL AMPLIFIER. G. M. Malyshev and G. T. Razdobarin. (Translation)

The choice of optimal sensitivity and gain of electron-optical amplifiers when used for the photography of high-speed processes is reviewed, and it is concluded that an advantageous receiver sensitivity comparison should be based on their equivalent quantum yields. It is shown that the equivalent quantum yield of an electron-optical amplifier can be made close to the quantum yield of the photocathode if the gain is chosen correctly. The choice of the gain is determined by the number of image elements and the measurement accuracy, which must be reconciled with the number of quanta. For each value of the gain, starting with some limit, there is a definite interval of measurable number of quanta and a corresponding interval within which the quantum yield of the electron-optical amplifier is close to its optimal value (the quantum yield of the photocathode) This interval can be determined from the known curve of equivalent quantum yield of the photographic film. If the measured range of exposures is sufficiently broad, this interval becomes somewhat narrower at low gain. It broadens with increasing gain. Too high a gain for a given number of quanta does not make it possible to obtain the necessary number of image elements and the accuracy attainable when the gain is optimally chosen. The noise due to the dark current of an electron-optical amplifier is much smaller than the noise of a photomultiplier and need be taken into account only when the exposure time is very large. (JPRS)

4489 A FAST NEUTRON FLIGHT TIME SPECTROMETER UTILIZING THE RECOIL ALPHA PARTICLES. A. Ádám, Gabriella Pálla, and P. Quittner (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 17: 353-60(1964).

A fast neutron spectrometer built for the investigation of nuclear reactions induced by 14.7-Mev neutrons produced by a $^3H(d,n)^4He$ source is described. The zero time

in the time-of-flight measurement is determined by the recoil alpha particle. This method is compared with another conventional procedure in fast neutron spectroscopy, in which a pulsed neutron source is used. The usual data and – in order to illustrate the spectrometer characteristics – measured flight time spectra of the $^{12}C(n,n')$ neutrons are given. (auth)

4490 HIGH-PRESSURE CHAMBER FOR STANDARD DOSIMETRY. E. Tschirf and H. Wildpaner (Osterreichische Hochschule, Vienna). Acta Phys. Austriaca, 18: 287-91(1964). (In German)

A device for absolute measurements, designed to express gamma doses according to the x-ray definition, was developed for the calibration of radiation sources. The theory of the device is outlined, and a description is given. The calculation of the dose output and the pertinent correction factors is indicated. (J.S.R.)

4491 MEASURING DEVICE FOR DIRECT DETECTION OF RADIOACTIVE AEROSOLS. E. Tschirf and H. Schuh (Osterreichische Hochschule, Vienna). Acta Phys. Austriaca, 18: 347-51(1964). (In German)

A measurement device is described in which aerosols are collected on a membrane filter in the shape of a cylindrical jacket around the counter tube, so that the filter support is also the counter support. It can be operated continuously for 24 hr without a filter change. The capacity of the installation to measure activity curves for both constant concentrations and for decaying concentrations was indicated using extremely theoretical cases. (J.S.R.)

4492 USE OF THE ELECTRON PORTION OF A GEIGER-MUELLER PULSE FOR ACTIVATION OF A DEADTIME-SHORTENING QUENCHING CIRCUIT. J. Harms and H. Weiss (Osterreichische Hochschule, Vienna). Acta Phys. Austriaca, 18: 352-8(1964). (In German)

In the construction of a circuit to shorten the deadtime, the time decay of the discharge was investigated with high time resolution for the halogen-quenched tubes used. At the beginning of the discharge, a pulse constituent of short lifetime and very large amplitude was observed. It is suitable for triggering the quenching circuit. The fraction of this pulse to the total pulse was measured in dependence on the tube voltage. A distinction could be made in size and course of the discharge in normal and extremely low counting rates. An explanation was sought. The deadtime was reduced from 200 to 20 μsec by use of the quenching circuit on counting tubes of the Valvo 18506 type. (tr-auth)

4493 ELECTRON BACKSCATTERING ON SOURCE-SUPPORTING FOILS IN BETA SPECTROMETERS. Peter Riehs (Osterreichische Studiengesellschaft für Atomenergie, Vienna). Acta Phys. Austriaca, 18: 359-63(1964). (In German)

The deformation of the spectra by backscattering on the source-supporting foils was investigated using ^{198}Au as the source and Al foils from 0.15 to 2.55 mg/cm^2 as the support. The relative backscattering as a function of the energy, with the foil thickness as a parameter, gave an asymptotic behavior at the abscissa that showed no interfering effect of the support thickness. The relation between support thickness and electron energy showed that at 8% backscattering, deviations from a straight-line Curie curve occurred. At small thicknesses the backscattering was proportional to the thickness. (J.S.R.)

4494 POINT COUNTER WITH QUENCHING VAPOR ABOVE THE FREE SURFACE OF THE LIQUID (EXO-ELECTRON DETECTOR). Mieczysław Piróg (Pedagogical Coll., Opole, Poland), Ignacy Stepniowski, and Bogdan Sujak. Acta Phys. Polon., 26: 3-10(July 1964).

An open point counter with a quenching vapor above the free liquid surface and with a pulse amplitude of approximately 2 v was constructed. The counter is destined for exoelectron emission investigation and is also well adapted to the detection of alpha, beta and gamma radiation. The characteristics of the counter were investigated for the following liquids: ethyl alcohol, methyl alcohol, n-propylic alcohol, and n-butylic alcohol. Characteristics were traced for various temperatures. (auth)

4495 SEMICONDUCTOR DETECTOR SPECTROSCOPY OF THE NUCLEAR REACTIONS O^{16} + d, O^{18} + p. Georges Amsel (Ecole Normale Superieure, Paris). Ann. Phys. (Paris) (13), 9: 297-344(May-June 1964). (In French)

Semiconductor detectors were used to study the reactions ^{16}O + d and ^{18}O + p. The principles of semiconductor detectors, and their fabrication, characteristics, resolution, stability, and experimental utilization are reviewed. The preparation of the oxygen targets by anodic oxidation on Al and the performance of the Al_2O_3 films (non-metalized and metallized) are reported. The experimental techniques and the results obtained are discussed in some detail. The theoretical interpretation of the data showed the validity of the Breit-Wigner R matrix theory in the excitation region at 9 Mev in ^{18}F for the emission of alpha particles. The existence of selection rules of isotopic spin in the same excitation region for ^{18}F and ^{19}F was confirmed. The theory of (d,p) stripping at proton emission energies of the order of 1 Mev was verified. (J.S.R.)

4496 A COMPTON SPECTROMETER WITH A P-N JUNCTION PARTICLE DETECTOR. H. Aiginger (Atominstitut der Österreichischen Hochschulen, Vienna). Atomkernenergie, 9: 355-8(Sept.-Oct. 1964). (In German)

An experiment was carried out to study replacing the scintillation counter normally used for the detection of the Compton electrons by a p-n semiconductor detector. The high resolution of these detectors for conversion electrons and the sharply defined Compton edges of γ spectra attained with these detectors offered the probability of an improvement in resolution. The experiment showed an improvement of 7% in a usual Compton spectrometer to 3.2% in this arrangement. In evaluating this improvement it is necessary to know the contribution of amplifier noise to line width and the resolution of the detector for monoenergetic electrons. The measurement of both is described. (auth)

4497 COMPARING EXAMINATIONS ON SIMPLEST SOLID DOSIMETERS. Th. Tuchscheerer (Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atomkernenergie, 9: 371-4(Sept.-Oct. 1964). (In German)

An arrangement is described by which the dose distribution on the surface of plain samples in an inhomogenous dose field can easily be determined by a single measurement. Regeneration ability and radiation sensitivity of dosimeter glasses were investigated. The qualifications were considered normal glass and plexiglas for this method of dosimetry. The investigations were related to the dose range of 10^5 to 10^7 rad. (auth)

4498 NUCLEAR INSTRUMENTATION. NO. 20. Bull. Inform. Sci. Tech. (Paris), No. 84, Suppl., 1-38(June 1964). (In French)

The application of computers to the performance and analysis of experiments in nuclear physics is discussed; and some instruments are briefly described, including counters, a pulsed neutron generator, atmospheric monitors, and a fast photomultiplier with a high output current. (D.C.W.)

4499 NEUTRON AND GAMMA-RAY RATE SENSITIVITIES OF SEVERAL DYNAMIC DETECTORS USED IN RADIATION EFFECTS. R. M. Kloepper (International Business Machines Corp., Owego, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 137-44(Nov. 1964).

The absolute rate-sensitivities of several burst sensors to neutrons and to gamma rays in the mixed field of the Sandia pulsed reactor environment were measured, using shielding techniques for variation of the neutron-to-gamma ratio over a factor of five to ten. The spectral changes effected by the shields are discussed. The sensors tested were: two reverse-biased preirradiated silicon diodes, MgO-RAD and phosphorphotodiode; and a fission ^{238}U detector. The ratio of the sensitivities of the detectors were 4.8, 7.8, 9.1, 22, and 46 ($\times 10^{-11}$ R-cm^2/neutron (Pu)), respectively. (auth)

4500 COBALT GLASS DOSIMETRY. K. D. Friddell. IEEE (Inst. Elect. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 155-63(Nov. 1964).

The fading of radio-induced absorbancy of cobalt glass as a function of exposure rate and time was investigated. A linear accelerator (Linac) and a 600 Curie cobalt-60 source were used. The fading of the absorbancy was found to obey an empirical relationship over four orders of magnitude of the form $A(t) = A(t_0) - n \ln t/t_0$ where $A(t_0)$ is the absorbancy at time t_0. The slopes of the fading curves (n) were found to depend upon the initial absorbancy $A(t_0)$ and wavelength. The difficulties of using a calibration curve determined with a low-exposure rate source for Linac dosimetry are briefly discussed. (auth)

4501 VARIATION OF THE EFFICIENCY OF A PERSPEX ČERENKOV COUNTER WITH DISCRIMINATOR BIAS AND PHOTOMULTIPLIER VOLTAGES. Krishan Mahesh (Muslim Univ., Aligarh, India). Indian J. Pure Appl. Phys., 2: 325-7(Oct. 1964).

The variation of the 'erect to inverted' ratio of the counting rates of a Čerenkov counter with a blackened perspex radiator was investigated by varying the discriminator bias and photomultiplier voltages. It was observed that although the ratio increases initially with the discriminator bias, it falls off slowly at higher values of the bias. The cause for the fall in the ratio at higher values of bias was attributed to an appreciable reduction in the 'back efficiency' of the detector due to the blackening of the radiator. The variation of the ratio as a function of the photomultiplier voltage at a fixed bias is also discussed. The optimum combination of the discriminator bias and the photomultiplier voltages for maximum efficiency of the perspex Čerenkov counter with a perfectly blackened radiator was found to be 15 and 920 v, respectively. (auth)

4502 MULTIPLE-CHANNEL RECORDER OF ATMOSPHERIC RADIOACTIVITY. V. Matulevičius and B. Styra (Inst. of Geology and Geography, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 123-30(1964). (In Russian)

The arrangement of the principal assemblies of the recorder is described. The instrument is supplied with a doubled band drawing mechanism, which gives it a certain universality. The deposition of the aerosols in the recorder takes place in two ways: by way of electric discharge (electrofilter) and by filtering the air through cloth filters. The recorder is designed for use in an observation station carrying on observations in the field of nuclear meteorology. (auth)

4503 ^{40}K AND ^{137}Cs MEASUREMENTS WITH THE WHOLE-BODY COUNTER OF BOLOGNA. C. Melandri, V. Prodi, and O. Rimondi (CNEN, Bologna). Minerva Nucl., 8: 252-8(Sept.-Oct. 1964).

The Bologna Whole-Body monitor is described. The shielded room is built with steel brick 16 cm thick and has inner dimensions: 2.70 × 2.10 × 2.10 m, so as to allow widely differing geometrical arrangements. For gamma detection a 9 in. × 4 in. (Na(Tl) cylindrical crystal was used: its background inside the room is 1471 counts per minute in the 0.1 to 1.9 Mev energy range. With this unit ^{137}Cs and ^{40}K were measured in 14 individuals: average levels for ^{137}Cs were found to be 7.0 mμC and for ^{40}K 2.0 g per kg bodyweight. A large plastic scintillation unit (30 × 20.2 × 17 cm) scanned by two EMI 9530 5 in. photomultiplier tubes was also tested and found satisfactory. Two or three units of this kind, set up in parallel, could serve as a highly efficient, inexpensive scanner. (auth)

4504 LOW-BACKGROUND BETA COUNTERS FOR IODINE-131 SOURCES. C. F. Barnaby (University Coll. Medical School, London). Nature, 204: 68-9(Oct. 3, 1964).

Two G-M counters, each having windows measuring 2.5 × 0.8 cm, are used in anticoincidence to determine the ^{131}I activity on chromatography paper. The rectangular windows provide high counting efficiency, and the anticoincidence arrangement reduces the background to about 1.5 cpm. A typical counting time for determining 2 picocurie with 10% accuracy is 204 min. (T.F.H.)

4505 PRINCIPLES OF A MAGNETIC COMPTON SPECTROMETER FOR NEUTRON-CAPTURE γ RAYS. H. Daniel (Max-Planck-Institut für Kernphysik, Heidelberg). Nucl. Instr. Methods, 31: 13-17(Dec. 1, 1964). (In German)

A new focusing principle for a magnetic Compton spectrometer is developed, which allows the use of a broad and high-plane converter foil. The instrument is of the "flat" type with two slits between converter and detector. The spectrometer is particularly suitable for neutron capture γ rays. (auth)

4506 THE SPHERICAL CONDENSER AS A HIGH-TRANSMISSION PARTICLE SPECTROMETER. III. CONSTRUCTION AND CALIBRATION. H. H. Hubbell, Jr., W. J. McConnell, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Nucl. Instr. Methods, 31: 18-24(Dec. 1, 1964). (ORNL-P-434)

A spectrometer has been constructed with an angle χ of one radian. The inverse square electric field between the plates of a spherical condenser focuses charged particles leaving a point or disk source located on the inner sphere. Particles leave the region of electric field through an annular slit at the focal position and are detected with a Faraday cup and vibrating reed electrometer. Energy resolution and transmission have been tested with an isotropic electron gun and with Auger electrons, and are 6.25% and 25% respectively between 50 ev and 32 kev, in agreement with theoretical expectations. The spectrometer is useful down to 0.5 ev although calibration has not been made as precisely. A beta ray and secondary electron spectrum of ^{64}Cu negatrons and positrons has been obtained from a cavity source of copper which approximates an infinite, isotropic, homogeneous, radioactive medium. Multicurie sources were used and observed currents were of the order of 10^{-13} ampere from 0.5 ev to 40 kev. (auth)

4507 LOCALIZATION OF SPARKS IN SPARK CHAMBERS THROUGH MAGNETOSTRICTIVE EFFECTS. G. Giannelli (Università, Bari, Italy). Nucl. Instr. Methods, 31: 29-34(Dec. 1, 1964).

An array of parallel wires is used as one of the spark-chamber electrodes. The wires are made with a magnetostrictive material. It has been found that high magnetic fields are produced into the wire at the position of the spark by the spark current, which produce in the wire an elastic deformation that propagates along the wire as an elastic wave and can be detected at a distance as done in magnetostrictive delay lines. A precision of 1 mm in the localization of the sparks and a resolution of 2 mm for multiple sparks starting from the same wire have been obtained. (auth)

4508 SOME ASPECTS OF LEAST-SQUARE ANALYSIS OF PARTICLE TRACKS WITH ORTHOGONAL POLYNOMIALS. Y. S. Kim (Ohio State Univ., Columbus). Nucl. Instr. Methods, 31: 35-40(Dec. 1, 1964).

It is shown that a certain set of orthogonal polynomials can simplify the analysis of particle tracks. General expressions for an arbitrary order of fit are given for the various error terms and several specific examples are examined for straight line and parabolic tracks. An example of analysis involving higher order fit is also given. (auth)

4509 OBSERVATION OF PARTICLE TRAJECTORIES IN A WIDE GAP SPARK CHAMBER. W. R. Dawes, Jr. and R. M. Kalbach (Univ. of Arizona, Tucson). Nucl. Instr. Methods, 31: 41-4(Dec. 1, 1964).

A study has been made of the reliability with which the space angle of a spark in a wide-gap spark chamber may be taken as a measure of the angular inclination of the trajectory of the initiating particle. For an 8-in.-gap helium-filled chamber, efficiencies as high as 81% were observed for sparks making angles less than 8° with the plate normal and whose angular deviation from the actual trajectory was 3° or less. For larger angles, the efficiency was observed to decrease substantially. Threshold operating conditions for chambers with gaps of 2 in. and 5 in. are also discussed. (auth)

4510 STUDY OF SPURIOUS SCATTERING IN NIKFI-R NUCLEAR EMULSIONS. U. Krecker (Deutsche Akademie der Wissenschaften, Berlin). Nucl. Instr. Methods, 31: 55-60(Dec. 1, 1964). (In German)

Properties of spurious scattering have been investigated in various batches of NIKFI-R nuclear emulsions with thickness of 400 μm. It is shown that the variation of spurious scattering from batch to batch is greater than the variation in emulsions developed in different ways. The mean value of the second differences increases with increasing dip angle of the measured tracks, but the mean value of the third differences remains constant. Spurious scattering measured in the same plate on tracks of particles with different momenta (3.5 and 10 Bev/c) shows an agreement in the second differences and differs slightly in the third differences. (auth)

4511 FAST DELAYED COINCIDENCE TECHNIQUE: THE XP1020 PHOTOMULTIPLIER AND LIMITS OF RESOLVING TIMES DUE TO SCINTILLATOR CHARACTERISTICS. G. Present, A. Schwarzschild, I. Spirn, and N. Wotherspoon (New York Univ., New York). Nucl. Instr. Methods, 31: 71-6(Dec. 1, 1964).

Tests of the XP1020 photomultipliers in a delayed coincidence apparatus using plastic scintillators are described. Prompt resolution curves were measured as a function of energy loss in the scintillators and triggering levels of the fast discriminators used to process the multiplier outputs. The best resolution obtained with ~1 Mev loss in each scintillator was 2.1×10^{-10} sec (fwhm). The effect of finite growth and decay times of the light output from commonly used scintillators on the ultimate resolving time is considered. It is shown that the growth time resulting from finite transfer times in the scintillator, has a drastic effect upon the available time resolution and is probably the limiting factor in obtainable resolution with the photomultipliers. (auth)

4512 SHAPE OF THE RANDOM SUM PHOTO-PEAK IN SCINTILLATION SPECTROMETRY. A. Jasinski, J. Ludziejewski, and J. Bialkowski (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk, Poland). Nucl. Instr. Methods, 31: 90-2(Dec. 1, 1964).

The pulse-height distribution of the random-sum photopeak is studied with a scintillation spectrometer. It is shown that the shape of this peak is strongly dependent on that of the analyzed pulses and on the opening time of the input circuit of the analyzer. The experimental pulse-height distribution is compared with the calculated one. (auth)

4513 FAST COINCIDENCE CIRCUIT WITH AVALANCHE TRANSISTORS. W. Michaelis, H. Schmidt, and C. Weitkamp (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instr. Methods, 31: 93-5(Dec. 1, 1964). (In German)

A fast coincidence circuit using avalanche transistors is described. Excellent results can be obtained even with slow scintillators. In a fast slow coincidence assembly with $\frac{3}{2}$" × 2" NaI(Tl) crystals and RCA 6810 A photomultipliers a resolving time of 1.6 nsec at nearly 100% coincidence efficiency was realized for the ^{60}Co gamma ray cascade. The circuit is stable and reliable. (auth)

4514 DETERMINATION OF THE INTENSITY OF γ TRANSITIONS AT LOW ENERGY BY EXTERNAL CONVERSION. J. Oms and P. Chedin (Faculte des Sciences, Grenoble, France and Centre d'Etudes Nucleaires, Grenoble, France). Nucl. Instr. Methods, 31: 96-105(Dec. 1, 1964). (In French)

A review is made of data on the photoelectric effect. The use of a cylindrical source-converter geometry–source coating a cylinder surface, and converter stretching along the cylinder axis, in a flat β spectrometer is shown to minimize the absorption of γ rays in the source and, even at low energies, to minimize the influence of the photoelectron angular anisotropy. Numerical values of the anisotropy correction factor are given for a wide energy range, using uranium, lead, and tin converters and several sets of geometrical parameters. (auth)

4515 SEMI-CONDUCTOR PROBE FOR INVESTIGATING ACCELERATOR BEAM PULSES. H. E. Conzett, L. B. Robinson, and R. N. Burger (Univ. of California, Berkeley). Nucl. Instr. Methods, 31: 109-11(Dec. 1, 1964). (UCRL-11492)

An instrument which makes possible the investigation of individual beam pulses from a cyclotron is described. It utilizes a fully depleted diffused–silicon junction detector of 100 to 200 microns thickness. The detector characteristics of fast charge collection time (~1 nsec) and of inherent amplification are important in this application. Examples of the detector system response to beams from the Berkeley sector-focused cyclotron are presented. (auth)

4516 PULSE SHAPE DISCRIMINATION. M. L. Roush, M. A. Wilson, and W. F. Hornyak (Univ. of Maryland, College Park). Nucl. Instr. Methods, 31: 112-14 (Dec. 1, 1964).

A method for separating the scintillation signals from particles with different specific ionization is described which is relatively insensitive to signal amplitude. It is based upon a measurement of the zero-crossing time for signals produced by RC differentiation of dynode voltage pulses. The circuit utilizes the signal from a single-photomultiplier dynode and operates satisfactorily at high counting rates. In the case of gamma-neutron discrimination in NE-213, excellent separation was observed over a range of amplitudes corresponding to recoil protons of 0.5 to 15 Mev energy. The acceptance efficiency for the recoil proton events drops to 50% at 0.3 Mev. Good experimental results are also shown for gamma-alpha discrimination in a stilbene scintillator. In addition, the pulse-shape sensing circuitry was used to separate small dynode signals due to low-intensity scintillations in NaI from phototube noise pulses of comparable amplitude. Calculations were made to select those circuit parameters which provide the optimum experimental ability to separate events due to two kinds of particles. Graphic displays of this optimization are shown for gamma-neutron discrimination in stilbene, NE-213, and NE-150 scintillators. A comparison is made between the present procedure and the theoretically optimum use of the shape differences. This method of shape discrimination appears to make efficient use of the information available in the pulse shape. (auth)

4517 A HIGH-EFFICIENCY DETECTOR FOR NEUTRON CAPTURE CROSS SECTION MEASUREMENTS. E. Haddad, R. B. Walton, S. J. Friesenhahn, and W. M. Lopez (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Instr. Methods, 31: 125-38 (Dec. 1, 1964).

A large liquid scintillator of modular construction has been developed for the purpose of measuring neutron capture cross sections for neutron bombarding energies from 0.01 ev to 30 kev. The detector configuration consists of a central, 2 ft diameter, hollow Plexiglas cylinder surrounded by an array of forty-four 9-in.-diameter, hollow Plexiglas cylinders ("logs"). These cylinders contain a total of 4000 liters of decahydronaphthalene and appropriate wavelength shifters. The pulse height resolution of the detector for capture gamma rays emitted from the 4.91 ev resonance in gold is 28%. With the discriminator bias set to accept pulses ≤3.0 Mev, the detection efficiency, for typical capture resonances and neutron binding energies between 6 and 8 Mev, is (81 ± 6)% and is essentially independent of gamma-ray cascade mode. Measurements demonstrate that isotopic assignments can be made to resonances, using normal samples, when the neutron binding energies differ by 300 kev or more. Data also indicate that the detector can be used to measure alpha (σ_c/σ_f) for fissionable isotopes, including the highly radioactive ones, which are particularly difficult to measure with other detectors. (auth)

4518 VISUAL OBSERVATION OF BEAM PROFILES. D. M. Binnie, A. Duane, D. B. Miller, W. W. Neale, J. A. Newth, D. C. Potter, and J. Walters (Imperial Coll. of Science and Tech., London). Nucl. Instr. Methods, 31: 153-6 (Dec. 1, 1964).

The "profile" of a high-energy separated beam from the proton synchrotron at CERN has been observed on a television screen by means of a device incorporating a single image intensifier. The usefulness of this system as a beam monitor is reported and some possible improvements are suggested. (auth)

4519 THE CALIBRATION OF A NaI(Tl) SCINTILLATION SPECTROMETER USING A PHOTON MONOCHROMATOR. J. F. Hague and R. E. Rand (University Coll., London). Nucl. Instr. Methods, 31: 157-68(Dec. 1, 1964).

The use of a photon monochromator for calibrating a total absorption NaI(Tl) spectrometer is described. Response functions have been obtained for photon energies up to 28 Mev and used to construct a response matrix. A particular advantage of this calibration method is that the integration of response functions over the energy channels is eliminated. The measured matrix, after suitable smoothing and grouping, was inverted and used in the measurement of a 28-Mev bremsstrahlung spectrum. Agreement of this measurement with theory provides confidence in the calibration. Formulas are given for the errors, owing to counting statistics, in the experimentally determined spectrum, special attention being given to the effect of smoothing the matrix and pulse height spectrum and of grouping the channels in the bremsstrahlung spectrum. (auth)

4520 SPECTRUM STABILIZATION WITH VARIABLE REACTANCE GAIN CONTROL. P. K. Patwardhan (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instr. Methods, 31: 169-72(Dec. 1, 1964).

This paper describes a novel and simple method of spectrum stabilization effected by "overall" gain control employing variable capacitance p-n junction diodes. The stabilizing peak is referenced directly from the analyzer store. Digital windows set on the stabilizing peak sense the magnitude of the spectrum shift and generate an analog signal of appropriate polarity and amplitude. This is applied as a reverse bias to a variable capacitance diode causing the effective feedback capacitance of a charge sensitive amplifier to change. This holds the spectrum in a fixed position. The high gamma-ray resolution (0.1 to 0.2% fwhm at 6 Mev) obtainable with the lithium-drifted germanium detectors call for an amplifier stability of 1 part in 10,000. At lower gamma energies the amplifier noise contributes primarily to the line width, while at higher energies, where the amplifier noise contribution is negligible, gain drifts of the order of 0.1 to 0.01%, cause line broadening. The system is capable of efficiently correcting these orders of drifts. Typical resolutions obtained with the stabilizer are 6.3 kev (fwhm) for 2.614 Mev gamma rays from a Th(B + C + C") source and 4.15 kev for 1.333 Mev ^{60}Co gamma rays. (auth)

4521 G-VALUE MEASUREMENTS WITH DIFFERENTIAL CALORIMETER. Branislav Radak, Mihailo Karapandžić, and Olga Gal (Inst. of Nuclear Science "Boris Kidrich," Vinčha, Yugoslavia). Nucleonics, 22: No. 11, 52-4(Nov. 1964).

A calorimeter is described that simply and directly measures the energy absorbed in irradiated samples of both $H_2C_2O_4$ for oxalic-acid dosimeters and Fe^{3+} for Fricke dosimeters. The values $G(H_2C_2O_4)$ and $G(Fe^{3+})$ were found to be 4.9 ± 1.5 and 15.10 ± 1%, respectively. (C.E.S.)

4522 AN EXPERIMENTAL DETERMINATION OF THE EFFECT OF TEMPERATURE ON THE COUNTING-RATE CURVE OF A SCINTILLATION DETECTOR. E. A. Berezin. Tr. Kuibyshevsk. Aviats. Inst., No. 7, 109-15 (1963).

The character of the change in the counting-rate of pulses that are recorded by a scintillation counter in relationship to the temperature was found experimentally. The counting-rate curve of the scintillation counter is temperature dependent. In addition to the effect of temperature, the character of the change in the pulse count rate is affected by the heating and cooling rate. For selected working specimens of the FEU-19 m, applicable to conditions of a general problem (inspection of erosion breakdown of materials at high temperatures), the optimum efficiency range may be established within the limits of 10 to 40°C with a change in the heating (cooling) rate of the detector of no more than 0.25 deg/min. The influence of the assumed resonance absorption effect may be accounted for as a systematic error. (OTS)

4523 A PROGRAMMING AND AUTOMATIC DATA COLLECTING SYSTEM FOR A NEUTRON DIFFRACTION SPECTROMETER. Walter Haelg (Federal Inst. of Tech., Zurich and Federal Inst. for Reactor Research, Würenlingen, Switzerland), Fritz Meier, and Fritz Gasser. Z. Angew. Math. Phys., 15: 481-5(1964).

A computer program for data recording in neutron diffraction analysis is discussed. It allows control of three pairs of angles for two independent neutron spectrometers, altogether 12 different angular values. The input data for the computer and control unit are introduced by punched tapes and then transfered into two magnetic core memories. Seven decade scalers were used for counting neutron and clock pulses. A detailed operation flow chart of the computer is included. (M.C.G.)

4524 MAGNETIC FIELD CONTROL FOR A BETA SPECTROMETER. CONVERSION SPECTRUM AND CONVERSION RATIO OF 79.51 kev AND 88.97 kev TRANSITIONS OF Gd-158 AND Gd-156. Wolfgang Noerenberg (Technische Hochschule, Munich). Z. Angew. Phys., 17: 452-60(Aug. 1964). (In German)

After a review of the measurement methods for constant magnetic fields, the selection of the measurement generator principle for the present magnetic field control was established. A relative control accuracy of 10^{-5} of the fields adjustable to <0.01% between 20 and 1000 gauss was desired. The essential viewpoints for the solution of this problem, such as phase equality of the compensated alternating voltages and stability of the constant fields, were discussed; and the apparatus developed was described. The control circuit was theoretically analyzed and tested experimentally by measurement of the conversion electron spectrum of Gd(n,γ)Gd. The stability of the controlled magnetic fields was $<10^{-5}$ for several minutes and 5×10^{-5} for several hours. From the measured conversion electron spectrum, the following conversion ratios were determined. For the 79.51-kev transition in ^{158}Gd, $L_1 : L_2 : L_3 : M : N : O = 0.13 \pm 0.02 : 0.91 \pm 0.02 : 1.00 \pm 0.02 : 0.51 \pm 0.02 : 0.10 \pm 0.02 : 0.013 \pm 0.005$. For the 88.97-kev transition in ^{156}Gd, $L_1 : L_2 : L_3 : M : N : O = 0.18 \pm 0.02 : 0.95 \pm 0.02 : 1.00 \pm 0.02 : 0.50 \pm 0.02 : 0.12 \pm 0.02 : 0.019 \pm 0.005$. The multipolar classification for these transitions was determined as E2 by comparison with the theoretical data of Rose. (tr-auth)

4525 CALCULATION OF THE DEFINITION CHARACTERISTICS OF A DOUBLE-FOCUSSING MAGNETIC 120° SPECTROMETER. Hans-Georg Clerc (Technische Hochschule, Munich and Yale Univ., New Haven) and Reiner Neuhausen. Z. Angew. Phys., 17: 460-4(Aug. 1964). (In German)

On the basis of exact field measurements, the particle trajectories in the middle plane of a double-focusing, 120° spectrometer were calculated, using an IBM 650 computer. For two different object distances, the calculated position and inclination of the image plane, the resolving power as a function of the radial opening angle, and the dispersion were obtained. An energy calibration of the spectrometer resulted from the effective deflection angle of the central beam. The results are compared with first-order calculations. An experimental test with the energy-analyzed electron beam of the Darmstadt linear accelerator showed that the resolution as well as the energy calibration are in good agreement with the calculations. (auth)

4526 SOLID-STATE CHARGED PARTICLE DETECTORS. Niels J. Hansen. Progr. Nucl. Energy, Ser. IX, 4: 1-72(1964). New York, The Macmillan Company, $4.25.

Information is included on solid-state theory, formation of the charge-depleted region, interaction of charged particles with matter, charge collection and the charge collection time, amplifier configurations and pulse rise time, en-

ergy resolution, and applications of junction and drifted detectors to nuclear spectroscopy. 55 references are included. (P.C.H.)

4527 FILM BADGE TEST PROCEDURES. Donald E. Barber and G. Hoyt Whipple (Univ. of Michigan, Ann Arbor). 11p. (CONF-642-16)

From Health Physics Society, Cincinnati, June 1964.

Procedures presently being developed to test the performance of film badges irradiated with beta, gamma, and neutron radiation are described. (P.C.H.)

4528 A PROCESS FOR THE PRODUCTION OF IONIZATION INDICATOR. Johan Erik Maul and Niels Wilhelm Holm (to Atomenergikommissionen). British Patent 970,960. Sept. 23, 1964. Priority date Nov. 10, 1961, Denmark.

A method of producing plastic-film radiation detectors is described. In an example, the film (90% PVC and 10% PVA) is soaked in a solution of 1 g methyl orange in 850 ml acetone and 150 ml water for 1 hour. The film can be attached to objects to be radiosterilized to indicate, after irradiation, that the proper dose was received. (T.R.H.)

4529 IMPROVEMENTS IN AND RELATING TO DOSIMETRIC GLASSES. Renee Bedier, Serge Carpentier, Henri Francois, Anne-Marie Grandclement, and Jean Meneret (to Commissariat à l'Énergie Atomique). British Patent 974,157. Nov. 4, 1964. Priority date Mar. 23, 1962, France.

A silver-activated phosphate glass is described for dosimetry of x and γ rays. It consists essentially of the metaphosphates of Li, Be, Na, Al, and Ag. The composition by wt % is Li_2O 5.45, BeO 1.41, Na_2O 6.38, Al_2O_3 6.58, Ag_2O 2.60, P_2O_5 77.58. (T.R.H.)

4530 AUTOMATIC RADIOACTIVE SAMPLE CHANGER. (to Atomic Energy of Canada Ltd.). British Patent 974,253. Nov. 4, 1964. Priority date July 21, 1961, United States.

An automatic sample changer for a radioactivity counter is described. The samples are stored in a column and carried by a slide at the bottom, one at a time, to the lead-shielded counting chamber. The shielding between storage and counting area is minimized by the distance between. (T.R.H.)

4531 IMPROVEMENTS IN OR RELATING TO RADIOACTIVITY MONITORING APPARATUS. Serge Dujancourt and Jean Roche (to Commissariat à l'Énergie Atomique). British Patent 974,606. Nov. 4, 1964. Priority date Mar. 9, 1962, France.

A device is described for monitoring filter cartridges for radioactivity. The cartridge is mounted on a carrier which can be fitted into a counting enclosure and rotated. The enclosure is shielded and has several detectors mounted in such a way that all of the cartridge is scanned. This procedure detects collected radioactivity and locates it accurately. (T.R.H.)

4532 METHOD AND ARRANGEMENT FOR THE ACOUSTIC AND/OR OPTICAL INDICATION OF RADIOACTIVE RADIATION. Guenter Trahlau (to Telefunken Patentverwertungs-gesellschaft mbH). German Patent 1,172,780. June 15, 1964. Filed Feb. 24, 1962.

The method consists of chopping a continuous signal, e.g. with the help of a multiplier, to obtain a periodic pulse repetition, of transforming the counter pulses into a d-c voltage, which is proportional to the counting rate, and of selecting discrete groups of single signals from this pulse repetition with the help of the transformed counter pulses in such a way that the number of single signals in such a group is a measure of the magnitude of the dose rate of the incident radiation. Above certain limits of the dose rate a continuous pulse repetition is emitted. A circuit arrangement for carrying out this method is given. (Gmelin Inst.)

4533 EQUIPMENT FOR THE IMAGE REPRESENTATION OF THE SURFACE DISTRIBUTION OF RADIOACTIVE ISOTOPES IN A BODY. Joseph Burns Stickney, Walter Edward Splain, and Carl Eugene Herring (to Picker X-Ray Corp.). German Patent 1,173,996. July 16, 1964. Priority date, June 15, 1959, United States.

The device described converts radiation signals into an oscilloscope record, which is then photographed. The intensity of the oscilloscopic beam is varied with the counting rate. For contrast enhancement the pulse rate meter controls the accelerating electrode of the cathode-ray tube. A multivibrator, which is controlled by the input pulses of the rate meter, furnishes intensity modulation pulses to the control electrodes of the cathode-ray tube. An essential feature of the invention is that nonlinear amplifiers are avoided. (Gmelin Inst.)

4534 ARRANGEMENT FOR THE RECORDING OF THE FREQUENCY DISTRIBUTION OF THE ENERGY OF A NUCLEAR RADIATION. Werner Hasselbeck (to Telefunken Patentverwertungs-gesellschaft mbH). German Patent 1,175,368. Aug. 6, 1964. Filed July 14, 1961.

The pulses to be analyzed are temporarily stored as lines on the face of a cathode-ray tube and are analyzed by means of a reading beam. The pulses are applied to horizontal deflection plates of a cathode-ray tube in such a way that a fixed line on the face of tube corresponds to a defined energy range. An exponential deflection voltage is periodically applied to the vertical deflection plates. As long as the vertical deflection time is short relative to the average interval between two pulses, it is more probable that a point is marked near the zero line than at a greater distance therefrom. By choosing the function of the vertical deflection voltage in a suitable manner it is possible to obtain any desired probability function for writing a signal point along the Y-coordinate. (Gmelin Inst.)

4535 A DEVICE FOR RECORDING GAMMA TOPOGRAMS. E. Yu. El'kind and V. L. Krivoshein. Russian Patent 162,896.

A device is described for recording gamma topograms. The unit contains a scintillation pickup, linear amplifier, single channel amplitude analyzer, count rate meter, system for controlling the movement of the scintillation pickup, and a recording unit. In order to increase definition in the scintigrams and reduce the total scanning time for the automatic regulation of the scanning step, an electrical threshold relay circuit is set up in the device to transform electrical pulses fed from the count rate meter into command signals for the system which reduces the scanning step when the scintillation pickup passes over a section with a high accumulation of radioactivity. (ATD)

4536 DEVICE FOR RECORDING NUCLEAR RADIATION. G. S. Neymark. Russian Patent 163,682.

A device for recording nuclear radiation is described, which includes a primary recording element and a binary counter. In order to widen the dynamic range of variation in the pulse-counting speed while securing high accuracy, the primary recording element is linked with the corresponding discharges of the counter through a system of keys. A "digit-voltage converter," which is connected through differentiating circuits and amplifying stages to a system of triggers associated with pulse-forming gates, is driven by the counter through a buffer register. The gates are driven by scaler stages connected to a sensor for detecting pulses corresponding to the rate of displacement of the probe. (ATD)

Radiation Effects

Refer also to abstract 4723.

4537 (BMI-X-10101) IRRADIATION OF NEUTRON DETECTORS AND ELECTRICAL COMPONENTS. Larry L. Yarger and Arnold M. Plummer (Battelle Memorial Inst., Columbus, Ohio). Oct. 26, 1964. Contract W-7405-eng-92. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Irradiation experiments on neutron sensors, electrical components, and miscellaneous items were carried out in the Battelle Research Reactor. A summary is presented of the operating history and radiation measurements for the experiments. (D.L.C.)

4538 (LA-DC-6649) CRYOGENIC TEMPERATURE MEASUREMENT IN A NUCLEAR RADIATION ENVIRONMENT. Charles R. Tallman (Los Alamos Scientific Lab., N. Mex.). [1964]. Contract [W-7405-eng-36]. 12p. (CONF-701-10). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

A general discussion of the effect of radiation on the performance of platinum resistance thermometers, copper-constantan thermocouples, and solid state devices is given. The radiation effects covered include rate phenomena and integrated dose effects on the precision of the measurement, particularly in the cryogenic temperature range. (auth)

4539 CONFERENCE ON RADIATION EFFECTS, UNIVERSITY OF WASHINGTON, SEATTLE, JULY 20-23, 1964. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 1-165(Nov. 1964). (CONF-617)

Seventeen articles are included; separate abstracts were prepared for 12. Five articles on photoconductivity in organic molecular crystals, transient response of transistors and diodes to radiation, neutron-induced damage to silicon rectifiers, dosimetry for radiation damage studies, and use of ferroelectrics for gamma dosimetry were previously abstracted in NSA as 18: 31914; 32228; 32232; 33190; and 34263. (P.C.H.)

For abstracts of individual papers see: 4499, 4500, 4540, 4541, 4542, 4543, 4544, 4545, 4546, 4547, 4722, and 4723.

4540 TRANSIENT RADIATION EFFECTS IN TRANSISTORS. E. A. Carr (Hughes Aircraft Co., Fullerton, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 12-23(Nov. 1964).

The measurement, analysis, and theory of primary photocurrent in transistors are discussed. Techniques for calculating or predicting primary photocurrent from pre-irradiation measurements were developed. For transistors driven into saturation by high-intensity pulses of gamma radiation, a radiation storage time is defined. A method for predicting radiation storage time entirely from non-radiation parameters is described. (auth)

4541 DESIGN TRADEOFFS FOR A NEUTRON RADIATION-TOLERANT SILICON TRANSISTOR. P. O. Lauritzen and D. J. Fitzgerald (Fairchild Camera and Instrument Corp., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 39-46(Nov. 1964).

A detailed study was conducted of the tradeoffs involved in the design of silicon planar transistors tolerant to fast neutron irradiation to 10^{15} nvt. Initial measurements made on irradiated 2N918 transistors indicated that breakdown voltage and collector current range must be sacrificed in order to improve device radiation resistance. The tradeoffs relating post-irradiation h_{FE} to transistor f_T, saturation region characteristics to breakdown voltage, and usable collector current range to length of emitter periphery are discussed in detail. The optimum design is a high frequency, low breakdown voltage transistor with a narrow usable current range. Transistors were fabricated having h_{FE} greater than 5 over a wide temperature range after irradiation to 10^{15} nvt. (auth)

4542 AN ANALYSIS OF STEADY-STATE NUCLEAR RADIATION DAMAGE OF TUNNEL DIODES. J. E. Dowdey (Arlington State Coll., Tex.) and C. M. Travis. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 55-9(Nov. 1964).

Eighteen 2.2-ma and four 10-ma P-substrate (N-on-P), and eighteen 2.2-ma and four 10-ma N-substrate (P-on-N) substrate tunnel diodes were irradiated to 1.5×10^{16} n/cm^2 (E > 0.3 Mev) and 2.2 10^{10} ergs/gm-(C) to investigate their radiation resistance. Peak currents were found to remain constant under these exposures while valley currents increased due to the increase in excess current. P-substrate diodes were found to be the more radiation-resistant, degrading about one half as much as the N-substrate units. (auth)

4543 RADIATION DAMAGE TO SOLAR CELLS ON RELAY I AND RELAY II. Ramond C. Waddel (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 60-8 (Nov. 1964).

The short circuit currents from 1 ohm-cm silicon n/p, silicon p/n, and gallium arsenide solar cells, bearing shields up to 60 mils thick and carried aboard the Relay I and Relay II satellites, were monitored. The currents from all cells decreased because of damage by the trapped particles in the Van Allen radiation belts. The currents from unshielded cells fell to about half the initial values in one day. Heavily shielded n/p silicon cells lasted about 10 times as long as similar p/n cells. Tentatively, gallium arsenide cells with 3 and 12 mil glass shields appeared inferior to silicon n/p cells with 60 mil fused silica shields, while gallium arsenide cells with 30 and 60 mil silica shields appeared superior, judging by comparing times to fall to given percentages of initial short circuit current values, and ignoring absolute efficiencies. The results from both satellites were in good agreement. (P.C.H.)

4544 A NEUTRON IRRADIATION TEST OF GERMANIUM BICRYSTALS. C. D. Taulbee and D. E. Nunn (Bendix Corp., Southfield, Mich.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 69-76 (Nov. 1964).

A neutron radiation test was performed on 12 germanium bicrystals of four different resistivities, to screen their radiation tolerance. Optical performance of four bicrystals was recorded intermittently during the test using a pulsed radiation-tolerant light source included in the test package. VI diode characteristics were also taken periodically throughout the test. The results obtained showed that the open circuit voltage response of the devices was degraded by 5×10^{13} nvt$_f$ and that their diode characteristics became linear in proportion to the donor concentration. The diode characteristics, however, were affected at a much lower value than anticipated, as shown by the zero bias conductance. (auth)

4545 EVALUATION OF HALL EFFECT MULTIPLIERS IN A RADIATION ENVIRONMENT. D. L. Nelson (Bendix Corp., Southfield, Mich.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 77-81 (Nov. 1964).

Indium arsenide (InAs) and indium antimonide (InSb) Hall effect devices were tested in gamma and neutron radiation to determine if they were suitable for use in the radiation environment experienced in a typical SNAP system. Total exposures of 5×10^7 R (Co-60 gammas) and 10^{15} nvt (E > 0.1 Mev) were accumulated on one group of devices. Effects of gamma radiation were negligible; however, neutrons did cause measurable changes in Hall coefficient (R_H) and input resistance (R_{in}). A simple method of compensating for parameter changes caused by radiation is suggested, which keeps errors in the multiplying constant less than 1% for InAs devices and less than 3% for InSb devices. (auth)

4546 SIMULATION AND VERIFICATION OF TRANSIENT NUCLEAR RADIATION EFFECTS ON SEMICONDUCTOR ELECTRONICS. C. T. Kleiner, G. Kinoshita, and E. D. Johnson (North American Aviation/Autonetics, Anaheim, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 82-104(Nov. 1964).

A technique for modeling semiconductor devices with a compatible circuit analysis program using an IBM 7094 digital computer and an S–C–4020 for CRT display is described. The models and program contain means of simulating the effect of an ionizing radiation environment. Both modeling and programming are facilitated by the use of a general-purpose compiler and solver termed TRAC (Transient Radiation Analysis by Computer). Comparison between TRAC simulation and experimental test results demonstrate close agreement at the indicated radiation levels. Methods for determining the semiconductor device parameter values from test data are illustrated. Likewise, TRAC program capability is tabulated with a circuit example illustrating application of the technique. A brief de-

scription of Equation Writing Capability is included with an example of input data required for this option. (auth)

4547 RADIATION INDUCED ELECTRICAL TRANSIENTS IN STRAIN GAGE AND TEMPERATURE TRANSDUCER CIRCUITS IN A PULSED REACTOR ENVIRONMENT. Joseph E. Ramus (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 111-22(Nov. 1964). (UCRL-7755)

Radioinduced electrical transients in strain gage, nickel temperature sensor, silicon temperature sensor, and thermocouple circuits were studied in the Kukla Prompt Critical Pulsed Reactor environment. Induced signals, which could obscure real data, were observed in many strain gage circuits. It was determined that the observed signals were the result of a voltage appearing between the strain gages and ground when the reactor was pulsed. Circuit arrangements that reduced the magnitude of the induced signals to less than 1 mv were devised and tested. Nickel temperature sensors and spot welded thermocouples operated satisfactorily in the reactor environment. No adverse effects due to transient signals and no changes in calibration were observed. The one type of silicon temperature sensor tested suffered large and permanent increases in resistance when exposed to a reactor pulse. (auth)

4548 EFFECT OF X-RAYS ON PROPERTIES OF POINT-CONTACT GERMANIUM DIODES. Z. Ya. Kleyman and T. A. Stefanova. Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 2, 160-5(1964).

The effect of x radiation on the characteristics of germanium p-n junctions was studied. The results showed that the current strength is unaffected in the forward direction, but increases sharply in the reverse direction, thus substantially lowering the rectification factor. The dependence of the photoelectric enhancement of the reverse current ΔI_r on the radiation intensity was investigated. The increase in the reverse current was attributed to an increase in free minority charge carriers. ΔI_r was found to be independent of the hardness of the x rays in the 45 to 60 kv range. This was shown to be due to a compensation between increasing the number of free electrons and decreasing their absorption capacity in the barrier layer. (D.C.W.)

4549 IMPURITY PHOTOCONDUCTIVITY IN GERMANIUM IRRADIATED BY FAST ELECTRONS. A. B. Gerasimov, S. M. Ryvkin, and I. D. Yaroshetskii (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 543-50(Sept. 1964). Translated from Fiz. Tverd. Tela, 6: 695-705(Mar. 1964).

The spectral response and kinetics of the photoconductivity in germanium irradiated by electrons with energies in the range 2.5 to 28 Mev were investigated. The energies of the localized levels associated with the radiation defects were determined and the recombination coefficients of some of them were evaluated. An optical charge transfer phenomenon associated with the impurity centers and induced impurity photoconductivity in the irradiated germanium are also discussed. (auth)

4550 PHOTOCONDUCTIVITY OF GERMANIUM IRRADIATED WITH FAST NEUTRONS. S. R. Novikov, E. E. Rubinova, and S. M. Ryvkin (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 690-1(Sept. 1964). Translated from Fiz. Tverd. Tela, 6: 896-8(Mar. 1964).

A study was made of the photoconductivity spectrum of n-type samples of Ge irradiated with various integrated doses of fast neutrons in a reactor at +70°C. Several energy levels produced by the irradiation were detected. (auth)

4551 ANNEALING OF RADIATION DAMAGE IN Si TRANSISTORS. Ernst Baldinger and Martin Lenzlinger (Universität, Basel). Z. Angew. Math. Phys., 15: 485-90 (1964). (In German)

Silicon planar transistors were irradiated with fast neutrons and with γ rays (^{60}Co). The reverse current and the current amplification factor at small emitter currents varied with radiation dose as expected. With γ rays, however, saturation was observed at rather small γ flux. Radiation damage in Si transistors could be totally annealed at 300°C. The annealing after neutron irradiation proceeded in two distinct steps at 120 and 280°C, respectively, whereas γ irradiation defects annealed in one step at 120°C. Comparison with measurements on homogeneous crystals led to the conclusion that the E-center (combination of a vacancy with a phosphorus atom) is responsible for most of the radiation damage observed in npn Si planar transistors. (auth)

4552 IDENTIFICATION OF SURFACE CURRENTS IN GERMANIUM POINT DIODES BY IRRADIATION WITH FAST NEUTRONS. Karl Zander (Hahn-Meitner-Institut für Kernforschung, Berlin). Z. Angew. Phys., 17: 422-4 (Aug. 1964). (In German)

The advantage of an investigation of the surface current constituent of a germanium point diode by irradiation with fast neutrons was indicated. By irradiation, the original n-conducting base area of the diode was gradually converted to p-conduction without alteration of the geometric ratios, but with probable alteration of the thickness of the inversion layer near the border and the space-charge distribution. Under the assumption of a surface charge density remaining constant during the irradiation in the first approximation, conversion of the n base leads to a decrease of the inversion layer thickness. It was assumed that for sufficiently large barrier potentials, the surface current path in the inversion layer was cut off. (tr-auth)

ISOTOPE TECHNOLOGY

General

Refer also to abstract 3829.

4553 (HW-83785) ISOGEN—A COMPUTER CODE FOR RADIOISOTOPE GENERATION CALCULATIONS. H. H. Van Tuyl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 38p. Dep.; $2.00(cy), 1(mn) OTS.

An option is available to use power level as input data instead of flux. The flux required to obtain the desired average power level over the irradiation time step is calculated. This flux may then be used in calculating fission product generation either normally, or with fission yields weighted in accordance with the fraction of fissions that results in each of three fission yields. Usually these three yields are for ^{235}U, ^{239}Pu, and ^{238}U, although others may be used instead. The time required for calculation is usually less than 0.1 sec per nuclide per time step, or about 1.5 sec for a 15 member, multibranched array. This is about a factor of 10 faster than other codes that have been investigated. (auth)

4554 APPLICATIONS OF NUCLEAR ENERGY IN AGRICULTURE. Alejandro Grobman. Bol. Junta Control Energía At. (Peru), 9: No. 48, 73-84(Jan.-Mar. 1964). (In Spanish)

The uses of radioisotopes and radiation in agriculture are tabulated. The more important progress made in studies on soil, physiology and vegetable autoecology, radioactive precipitation, and entomology is summarized. (J.S.R.)

4555 GENERAL TRENDS IN THE MARKET FOR FISSION PRODUCTS. Energie Nucl., 6: 313-16(July-Aug. 1964). (In French)

The development of the market for fission products is essentially bound to the possibilities of their use as heat source for electrical generation. The costs and characteristics of the most important radioisotopes are tabulated. The availability of these isotopes in the United States, United Kingdom, and France is discussed. (J.S.R.)

4556 IMPROVEMENTS IN OR RELATING TO PERMEABLE MEMBRANES. Charles Eyraud, Georges Caunas, Michel Eudier, and Daniel Massignon (to Commissariat à l'Énergie Atomique). British Patent 975,185. Nov. 11, 1964. Priority date Jan. 23, 1960, France.

A method of preparing porous nickel barriers for gaseous diffusion plants is described. A paste of 45 to 55 wt % Ni formate in water containing 2% gum and tragacanth or an alginate, acetone containing 5% methylmethacrylate or collodion, was applied to the tube. This was then heated to 240°C for 2 hours in a vacuum of 10^{-3} mm Hg. The mean pore radius obtained was 2 centimicrons and the molecular capacity 7.00×10^{-7} molecules of air/cm²/minute/cm Hg/difference in pressure. (T.R.H.)

Industrial Applications

4557 (AD-420596) NAVAL ISOTOPE APPLICATIONS: A SELECTED BIBLIOGRAPHY. R. H. Seabold and J. Jacovitch, comps. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Aug. 30, 1963. 73p. (TN-533). $7.60(OTS).

Publications on radioisotope applications are listed. Emphasis is placed on possible radioisotope uses for naval civil engineering in construction, facility and equipment maintenance, harbor engineering, engineering surveys, and engineering research. (auth)

4558 (AD-421605) THE USE OF AUTOMATED RADIOISOTOPIC TRACING METHODS TO REVEAL CONTAMINANTS ON PRINTED CIRCUIT BOARDS. Final Report. (Autonetics Div., North American Aviation, Inc., Downey, Calif.). Feb. 1962. Contract AF04(647)-923. 244p. (EM-3061). $17.00(OTS).

The feasibility and applicability of radioisotopic techniques and the attendant controls and equipment necessary to the implementation of automated processes in circuit board inspection are discussed. Notable improvement of circuit board reliability is achieved with a new method of contaminant control. Radioisotopes are used in tests which are conducted in the actual manufacturing environment. (auth)

4559 (ORNL-tr-387) USE OF RADIOACTIVE ISOTOPES IN THE METALLURGICAL INDUSTRY OF SOME OF THE SOVIET ECONOMIC GROUP COUNTRIES. V. I. Sinitsyn. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from At. Energ. (USSR), 16: 279-82[1964]. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10 (fs), $0.80(mf) JCL.

A brief survey is presented of the use of radioactive indicator methods and radioisotopes in the metallurgical plants of Czechoslovakia, East Germany, Hungary, Poland, and Rumania. The applications include purification of metals, steel production, thickness gaging, level regulations, moisture determination, etc. (D.L.C.)

4560 THE TECHNICAL AND ECONOMIC SIGNIFICANCE OF NUCLEAR RADIATION MEASURING EQUIPMENT AND OF RADIOACTIVE MATERIALS. W. Stremme (Frieseke Hoepfner GmbH, Erlangen, Ger.). Atomwirtschaft, 9: 158-60(Apr. 1964). (In German)

The associated development of measuring equipment and of applications for radioactive materials in industry, medicine, and research is discussed. The economic benefits and distribution of industrial control and measuring equipment, particularly, are considered. (D.C.W.)

4561 TOOL ACTIVATION FOR THE DETERMINATION OF THE CUTABILITY OF THIN SHEETS. R. Neider (Bundesanstalt für Materialprüfung, Berlin) and H. Peter. Atomwirtschaft, 9: 504-8(Oct. 1964). (In German)

A test procedure was developed by which even the smallest quantities of material abraded from the cutting edge of a tool can be measured. A tool is used whose matrix has been made radioactive by irradiation with thermal neutrons in a reactor. The small amount of material rubbed off the tool and left adhering to the stamping with each individual cut can be precisely determined by a radioactivity measurement. This process has been further developed but in the meantime has been put into practice in many cases including the testing of the cutability of hot and cold rolled dynamo sheets, the testing of the influence of the insulation on the cutability of such sheets, as well as of the cutability of welded seams in the sheets. (P.C.H.)

4562 RADIOISOTOPE APPLICATIONS IN INDUSTRIAL GAMMAGRAPHY. Ernesto Jibaja [Torre Tagle]. Bol. Junta Control Energía At. (Peru), 9: No. 48, 45-56 (Jan.-Mar. 1964). (In Spanish)

The use of radioisotopes as tracers for activation analysis, in methods that use the effect of radiation in matter, and in methods that use the effects of materials on radiation was analyzed separately in some detail. A typical example of each case is given. (J.S.R.)

4563 APPLICATIONS OF RADIOISOTOPES IN METALLURGY. Ignacio Frisancho Pineda. Bol. Junta Control Energía At. (Peru), 9: No. 48, 57-72(Jan.-Mar. 1964). (In Spanish)

The direct and indirect economies realized in the use of radioisotopes are summarized. The use of radioisotopes in metallurgy, particularly in the iron and aluminum industries, is tabulated. Specific illustrations are given of the use of the penetrating properties of radiation in the radiographic analysis of materials and scattering and self-scattering. (J.S.R.)

4564 SOME APPLICATIONS OF RADIOELEMENTS IN THE GAS INDUSTRY IN FRANCE. M. C. Tellier (Etudes et Techniques Nouvelles, Gaz, France), M. G. Courtois, and M. M. Garnier. Bull. Inform. Assoc. Belge Develop. Pacifique Energie At., 9: No. 51, 17-23(Aug. 1964). (In French)

Three applications of radioisotopes in the gas industry in France are discussed: labeling of a fogging oil, study of the ventillation of domestic premises, and determination of gas or water leaks in underground pipes. The techniques used, the sensitivity of the method, and the results are covered. (J.S.R.)

4565 THE USE OF RADIOACTIVE γ-RAYS IN INDUSTRIAL MEASUREMENT TECHNIQUES. Hermann Amrehn (Chemische Werke AG, Hüls, Ger.). Chem.-Ingr.-Tech., 36: 824-32(Aug. 1964). (In German)

Radioactive γ emitters are employed for continuous supervision of the level and density of a substance in closed containers, determination of the carbon or hydrogen content of organic substances, and for determination of heavy atoms. The advantage of radioactivity methods of measurement is that no direct contact need be established with the substance being checked, and the results of the measurements are not influenced by the conditions of the investigation. Radioactive measuring devices have attained a high degree of operational efficiency, stability, and accuracy. (auth)

4566 RADIOISOTOPES IN INDUSTRY. L. Z. Janosti. Euro Nucl., 1: 39-42(Sept. 1964).

What was once termed a by-product of nuclear energy, the radioisotope is now being used in ever-increasing quantities in numerous applications throughout industry. Some of the many radioisotope gages and their methods of application are described. (auth)

Power Application

4567 (MND-P-2762-A) FINAL SAFETY EVALUATION OF A SIXTY-WATT STRONTIUM-90-FUELED GENERATOR FOR A U. S. COAST GUARD AUTOMATIC LIGHT STATION. SNAP 7B. V. G. Kelly and H. N. Berkow (Martin-Marietta Corp. Aerospace Div., Baltimore). May 1962. Contract AT(30-1)-2345. 52p. Dep.(mn); $3.00(cy), 1(mn) OTS.

A safety evaluation was performed for the SNAP-7B generator system to determine if the safety design criteria with respect to mechanical, thermal, and radiation integrity were satisfied. Analyses were performed to assess the radiobiological effects in the event of release of the radioisotopic fuel. The shielding was evaluated to determine the safe working limits of personnel required to be near the generator. The entire safety evaluation is based upon a fuel loading of 245,000 Curies of radiostrontium. The evaluation is based on analytical procedures and test results. It is concluded that the safety criteria were satisfied and that the generator is safe for its intended use. (R.E.U.)

4568 RADIOISOTOPE-FUELED THERMOELECTRIC GENERATORS. William E. Kortier and Meyer Pobereskin. Battelle Tech. Rev., 13: No. 12, 3-8(Dec. 1964).

The need for dependable, unattended sources of power is being filled increasingly by radioisotope-fueled thermoelectric generators. A discussion of problems involved in their design and some steps being taken for improving such devices is presented. (auth)

Separation and Production

4569 (K-1625) TRANSIENT BEHAVIOR OF A SQUARE PLANT, SEPARATING A BINARY MIXTURE, OVER AN INFINITE RESERVOIR. D. W. Burton (Oak Ridge Gaseous Diffusion Plant, Tenn.). Nov. 30, 1964. Contract W-7405-eng-26. 16p. Dep.; $1.00(cy), 1(mn) OTS.

Solutions are given of the time-dependent problem of a square plant, separating a binary isotopic mixture, with fixed concentrations at the feed point. The initial time condition is taken to be that of a plant filled initially with feed material. Exact solutions for the entire concentration range are obtained, with an approximate result which is valid for early time periods. Others have solved this problem but the expressions are unwieldly for early periods of time. (auth)

4570 (SGAE-PH-6/1964) HERSTELLUNG VON Na^{24}- UND A^{41}-QUELLEN MIT EINEM ELEKTROMAGNETISCHEN ISOTOPENSEPARATOR. (Preparation of ^{24}Na and ^{41}Ar Sources With an Electromagnetic Isotope Separator). F. P. Viehboeck and H. Wotke (Osterreichische Studiengesellschaft für Atomenergie G.m.b.H., Physik-Institut, Seibersdorf and Vienna. Technische Hochschule). [1964]. 15p. Dep.

Preparation of ^{24}Na and ^{41}Ar sources for nuclear spectroscopic studies is described. The electromagnetic isotope separator of the Seibersdorf Reactor Center was used. (M.C.G.)

4571 (MLM-1206(Tr)) ISOTOPE SEPARATION DURING FREEZING OF WATER, AND DIFFUSION CONSTANTS OF D AND O^{18} IN THE ICE. W. Kuhn and M. Thuerkauf. Translated by H. A. Fischer for Mound Lab., Miamisburg, Ohio, from Helv. Chim. Acta, 41: 938-71(1958). 32p. Dep.; $2.00(cy), 1(mn) OTS.

In the partial crystallization of water, an enrichment of the HDO as well as of the $H_2{}^{18}O$ contained in water takes place in the crystalline phase. It is shown that this enrichment in the crystalline phase is determined by one separation parameter each, which can be calculated from the melting-point difference of HDO and H_2O, and $H_2{}^{16}O$ and $H_2{}^{18}O$ as well as from the molecular heat of fusion and the absolute fusion temperature. For the case of deuterium and ^{18}O enrichment, the separation parameter is determined experimentally. It amounts to $\delta_{E,W} = 1.71 \times 10^{-2}$ for the HDO enrichment in good agreement with the theoretically calculated value. For the enrichment of $H_2{}^{18}O$, $\delta_{E,W} = 5 \times 10^{-4}$. The fusion temperature calculated from the above for pure $H_2{}^{18}O$ is found at $t = +0.05°$. Fundamentally it is now possible to multiply the small separating effect occurring in the partial crystallization of water by means of a hair-pin counterflow system. For the conditions under which a multiplication could be practically conducted, the magnitude of the diffusion coefficient of D and ^{18}O in solid ice is decisive. These diffusion coefficients D were determined experimentally at −1.5 to −2°. They are identical for D and ^{18}O within the limits of error and have a value of $D = 1.0 \times 10^{-10}$ cm^2 sec^{-1}; it is approximately 10^5-fold smaller than the diffusion coefficient for the same particles in liquid water. Nevertheless, it follows from the diffusion coefficient measured in solid ice, that a given water molecule in the ice is transposed with its nieghbor approximately 10^5 times per second. A migration of molecules but not a migration of H ions or H atoms is involved for the diffusion in ice. On the basis of the measured separation parameters and the diffusion coefficients, the possibility of a multiplication of the separation by a hair-pin counterflow method has been discussed. By indicating an extensive analogy to the conditions occurring in a rectifying column, the number of separating stages, the throughput, the necessary reflux, the product output, and the startup period of a method based on the multiplication of the separating effect are given in a general manner and the equations are applied to the special case of the D_2O separation occurring during freezing of water. A practical application comes into consideration when it is possible to prepare crystals with a uniform linear dimension of 10^{-4} cm or less and when a circulation can be produced in a hair-pin counterflow installation. Reference was made to the possibility of preparing crystals of such magnitudes by freezing aqueous gels. (auth)

4572 REPORTS FROM THE GENEVA CONFERENCE. II. LESSONS DRAWN FROM FRENCH RESEARCH AND ACHIEVEMENTS IN THE SEPARATION OF URANIUM ISOTOPES. Claude Frejacques and Robert Galley. Ind. At., 8: Nos. 9-10, 63-7(1964). (In French)

The accomplishments in the field of the separation of

uranium isotopes by gaseous diffusion and by ultracentrifugation are discussed. An economic evaluation is made of the several factors involved in cost estimates. It is brought out that only the very big gaseous diffusion plants, corresponding to a program for the installation of enriched uranium reactors putting out at least 4000 Mw(e) per year, can expect to produce enriched uranium at an economically acceptable level. (tr-auth)

4573 ION OPTICAL EFFECTS OF BEAM STABILIZATION IN A LABORATORY MASS SEPARATOR. J. H. Dijkstra and K. J. Van Oostrum (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Instr. Methods, 31: 77-82(Dec. 1, 1964).

A pin stabilization device with feedback to both the acceleration voltage and deflection plates combines the speed of the deflection plate stabilization with the small ion optical effects of the stabilization on the high voltage. These two beam stabilizing systems are investigated by calculation and experiment. (auth)

4574 METHODS OF SEPARATING THE STABLE ISOTOPES. II. METHODS BASED ON REVERSIBLE PROCESSES. Gh. Vasaru. Rev. Chim. (Bucharest), 14: 285-9 (May 1963). (In Romanian)

A description is given of different methods of separating the stable isotopes based on reversible processes (distillation, isotopic exchange, centrifugation). The separation coefficient is defined for each case emphasizing the possibilities of applying the methods described and their practical uses. (auth)

4575 METHODS OF SEPARATING THE STABLE ISOTOPES. III. METHODS BASED ON IRREVERSIBLE PROCESSES. Gh. Vasaru. Rev. Chim. (Bucharest), 14: 474-8 (Aug. 1963). (In Romanian)

The theory of the elementary effect and thermal diffusion column are presented as well as the application of thermodiffusion in the field of isotope separations. (auth)

4576 METHODS OF SEPARATING THE STABLE ISOTOPES. IV. METHODS BASED ON IRREVERSIBLE PROCESSES. Gh. Vasaru. Rev. Chim. (Bucharest), 14: 605-9 (Oct. 1963). (In Romanian)

Methods for the separation of stable isotopes based on irreversible processes, namely the gaseous diffusion, mass diffusion, jet separation, and molecular distillation are discussed. The separation coefficient is defined for each method as well as the uses and application possibilities. (auth)

4577 METHODS OF SEPARATING THE STABLE ISOTOPES. VI. METHODS BASED ON SPECIFIC PROCESSES. Gh. Vasaru. Rev. Chim. (Bucharest), 15: 291-5(May 1964). (In Romanian)

The stable isotope separation methods based on specific processes, i.e., the electromagnetic and the photochemical method are presented. After giving some comparative data concerning the performance of separation methods in general, the choice criteria for these methods and the present trends in isotope separation techniques are given. (auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 4438 and 4456.

4578 (AI-Memo-64-102) PERT—A PERTURBATION THEORY CODE. H. P. Flatt (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 1964. 15p. Dep.(mn).

PERT performs linear perturbation theory calculations using punched output from AIM-5, AIM-6, FOG, or FAIM. It finds ΔK_{eff}, lifetime, effective beta, and weights cross sections. (auth)

4579 THE DESIGN OF EXPERIMENTS USING COMPILER LANGUAGE COMPUTER PROGRAMS. J. V. Kane (Bell Telephone Labs., Murray Hill, N. J.). Nucl. Instr. Methods, 31: 83-6(Dec. 1, 1964).

It is shown that FORTRAN and similar compiler systems are applicable to the needs of nuclear physics experiments using on-line computer systems. (auth)

4580 TWO-PARAMETER ANALYZER AND OTHER USE OF THE DIGITAL COMPUTER IN A NUCLEAR LABORATORY. A. C. L. Barnard, R. Keyes, J. A. Buchanan, T. A. Rabson, and G. C. Phillips (Rice Univ., Houston, Tex.). Nucl. Instr. Methods, 31: 147-52(Dec. 1, 1964).

An IBM 1401 computer has been in use in the Bonner Nuclear Laboratories for approximately one year. Digital sequencing equipment and analog pulse conditioning circuits have been built and programs written to enable the use of the computer in four ways: for fast aquisition and delayed time processing of two-parameter experimental data (with an option for real-time coarse processing), up to 1000 channels being available for each parameter; for fast readout and processing of data from commercial analyzers in the laboratory, resulting in a substantial increase in efficiency in the laboratory; for single-parameter applications, where the system is equivalent to two 1000-channel analyzers with real or delayed-time totalizing; and for general-purpose computing of nuclear problems. The system is capable of further refinement and expansion. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstract 4561.

4581 (AD-602049) FINAL SUMMARY TECHNICAL REPORT ON THE CALENDAR YEAR 1963 RAMJET TECHNOLOGY PROGRAM. VOLUME 10 OF 12. SECTION XVIII. HIGH-TEMPERATURE COATED TUNGSTEN STRUCTURES. J. K. Totten (Marquardt Corp., Van Nuys, Calif.). June 1964. Contract AF33(657)-12146. 32p. $1.00(OTS).

The goal of the high temperature coated tungsten structures program was to develop methods of protecting tungsten substrates, in oxidizing environments, to temperatures in excess of 3460°R. Material systems of binary, ternary, and quaternary alloys were synthesized in an arc-melting furnace and then screened for oxidation resistance using an oxyacetylene torch. This resulted in the development of a binary hafnium–tantalum alloy that withstood temperatures well above 3460°R, under oxidizing conditions. The oxide grown from the base alloy was well-bonded, thermal shock resistant, and dense. A feasibility study on the coating of the test specimens was accomplished by plasma-arc spraying and slurry coating the alloy powders onto tungsten and 90 percent tantalum–10 percent tungsten substrates of various configuration. This work demonstrated the feasibility of utilizing this very promising material system as a coating for oxidation protective refractory metals. (auth)

4582 (BM-RI-6560) ELECTRON-BEAM PURIFICATION OF HAFNIUM. Wallace E. Anable and R. A. Beall (Bureau of Mines. Albany Metallurgy Research Center, Ore.). 1964. Contract AT(11-1)-599. 34p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The purification of hafnium by electron-beam melting at moderate energy inputs and at low pressures was examined in detail. Most metallic impurities and hydrogen were removed in the first few minutes of operation; oxygen, carbon, and nitrogen were removed at a slower rate. Samples treated by electron bombardment suffered a small loss of weight and a gradual lowering of hardness. The magnitude of each change varied with the energy input and the duration of the melt. Analysis of the data confirms the loss of oxygen as a hafnium monoxide. Approximate activity coefficients for other contaminants are given. (auth)

4583 (DRI-2189) A STUDY OF THE SYNTHESIS AND PROPERTIES OF TRANSITION-METAL HYDRYLS. Final Summary Report. Charles B. Magee (Denver. Univ. Denver Research Inst.). Oct. 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1185. 55p. (EURAEC-1251). Dep.(mn); $3.00(cy), 2(mn) OTS.

There are single intermediate phases in the Li–Rh and Li–Ir systems. The stoichiometries of these phases are LiRh and LiIr. X-ray diffraction analyses show these phases to be hexagonal (one mole per unit cell) with the following lattice parameters and theoretical densities: for LiRh, $a_0 = 2.6520 \pm 0.0015$Å, $c_0 = 4.3594 \pm 0.0026$Å, density equal to 6.87 gm/cc; and for LiIr, $a_0 = 2.6493 \pm 0.0007$Å, $c_0 = 4.3970 \pm 0.0011$Å, density equal to 12.37 gm/cc. Evidence indicates that there are two eutectics in the LiRh binary system, one on either side of the intermediate phase LiRh. A tentative phase diagram for this system is presented. Hydryl compounds exist in both the Li–Rh–H and Li–Ir–H systems. Compounds of stoichiometries $(LiH)_4Rh$ and $(LiH)_4Ir$ are prepared by heating 4 to 1 molar ratio mixtures of LiH and the metal. At room temperature both compounds are grayish black, crystalline materials. $(LiH)_4Rh$ melts, forming a black, non-viscous liquid, at about 575°C. $(LiH)_4Ir$ does not melt below 850°C. The crystal structure of $(LiH)_4Rh$ is tetragonal with $a_0 = 11.240 \pm 0.054$Å and $c_0 = 8.932 \pm 0.036$Å. Assuming 16 moles of $(LiH)_4Rh$ per unit cell, the density is 3.17 gm/cc. This corresponds to a hydrogen density of 5.8×10^{22} H atoms per cc. The x-ray-diffraction pattern of $(LiH)_4Ir$ is similar to that of $(LiH)_4Rh$. Equilibrium hydrogen pressure measurements as a function of temperature and hydrogen concentration in the condensed phase indicate that, when hydrogen is added to 4 to 1 molar ratio mixtures of Li and Rh, the condensed material is single phase at temperature between 600 and 800°C and for all hydrogen concentrations up to that corresponding to the stoichiometry $(LiH)_4RhH$. Heats of solution of hydrogen in this presumed liquid phase have been calculated. The integral heat of solution of hydrogen in a liquid composed of Li and Rh to form a liquid of composition $(LiH)_4Rh$ is −12.5 kcal/g-atom hydrogen. Experiments with mixtures of cobalt and LiH or Li indicate that cobalt forms hydryls and, most likely, an intermediate phase with lithium. However, complete reaction was not effected as was the case with Rh and Ir. (auth)

4584 (EUR-1896.e) THE PREPARATION OF UO_2 BY FUSED SALT ELECTROLYSIS USING UO_2 OR UF_4 AS STARTING MATERIAL. M. Schlechter, J. Kooi (European Atomic Energy Community), R. Billiau, R. A. Charlier, and G. L. Dumont (Centre d'Étude de l'Énergie Nucléaire, Mol, Belgium). 1964. 42p. Dep.(mn).

Coarse crystalline UO_2 can be prepared by the electroreduction of UO_2Cl_2 or UO_2F_2 dissolved in molten LiCl–KCl eutectic or molten NaCl-KCl-$MgCl_2$ eutectic. The uranyl compounds are obtained by treatment of UO_2 or UF_4 in situ in the chloride melt with a gas mixture of hydrogen chloride and oxygen. In this connection it is found that moisture accelerates the oxidation of the fluoride. Electrolysis is carried out in a pyrex glass apparatus at a working temperature of 500°C, using graphite electrodes. The process in which the binary salt melt is used as solvent for the uranyl compound has been found capable of producing oxides with a composition ranging from $UO_{2.000}$ to $UO_{2.007}$. Using the ternary salt melt as solvent, a UO_2 product of less favorable O:U ratio is obtained. The possible cause of this is discussed. The crystal form is found to be dependent upon the degree of dryness of the melt and also upon the presence of chlorine in the melt in the case of the LiCl–KCl–fluoride salt. It is further observed that the presence of fluorides in the electrolytic bath favorably influences the formation of cube-shaped UO_2. The electrolytic yields obtained are discussed. The UO_2 products show density values, determined by liquid (H_2O) displacement, varying between 10.85 and 10.98 (g/cc at 25°C). (auth)

4585 (EURAEC-1177) MEASUREMENT OF SMALL SURFACES BY BET [BRUNAUER, EMMET, AND TELLER] ADSORPTION METHOD. Special Report No. 11. P. Chenebault (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble) and A. Schuerenkaemper (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). May 1964. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 031-60-10 (RDF). 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The measurement of surfaces of a few cm^2 is possible by using as an adsorbate a mixture of natural xenon and xenon-133. The vapor pressure of xenon at the temperature of liquid nitrogen is equal to 2.15×10^{-3} mm Hg, taking into account a certain correction for thermal transpiration. The surface measured for the glass is equal to the geometrical surface of the samples. For sintered uranium dioxide samples of different densities, the surface increases in inverse proportion to the density. This method further permits to measure the surfaces of samples with a high γ activity (irradiated UO_2, for example). (auth)

4586 (EURAEC-1190) PHYSICAL PROPERTIES OF UO_2 SINGLE CRYSTALS. Final Report No. 2, March 1, 1963–February 29, 1964. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 010-63-3 TEEB. 65p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A large number of UO_2 single crystals has been prepared for studies of the physical properties. Attempts to improve the preparation process, especially by using larger UO_2 cylinders prepared by slip casting, were successful. Large single crystals up to 10 g in weight were grown. A simple and reliable method allowing the variation of the composition of the single crystals (in the range between UO_2 and $UO_{2.25}$) has been developed. A device for the removal of plane-parallel layers of 0.3-micron thickness has been constructed. This equipment will enable the study of U self-diffusion in UO_2 single crystals. Furthermore, the experimental methods for the study of the sintering mechanisms in UO_2 are discussed. A new method for preparing thin foils of UO_2 suitable for transmission electron microscope observations has been applied. The thinning is achieved electrochemically at room temperature. Dislocations; precipitates of different shape, presumably U_4O_9; and fission fragment damage, i.e., tracks, clusters of point defects, and small dislocation loops have been observed and discussed. Furthermore, a complementary study of ferroelectric domains and fission fragment damage in $BaTiO_3$ has been made. The thermoelectric power of a series of UO_2 crystals with different excess oxygen content, has been measured as a function of temperature (100 to 600°K). The electric conductivity of UO_2 single crystals with O/U ratios varying between 2.00 and 2.06 has been determined after successive periods of reaction exposure (up to 1.6×10^{17} thermal neutrons per cm^2). The conductivity of the oxidized crystals decreased markedly upon irradiation and reached a saturation value at about 4×10^{15} fissions per cm^3. On the contrary, the conductivity of the stoichiometric specimens remained practically unchanged up to 1.6×10^{16} fissions per cm^3. Recovery experiments revealed the presence of an annealing peak around 725°C, the associated activation energy for defect migration being about 2.5 ev. This suggests uranium point defect migration. A study of the validity of the Low, Lee, and Pines method in the case of interaction of an electron with a single lattice oscillator has been made. The strong coupling polaron theory of Pekar has been applied to an exactly soluble model where the electron interacts with a single lattice oscillator. The thermal conductivity of an elongated prism of about 8 mm in length, presenting a slight oxygen excess has been measured between 4 and 300°K. At very low temperatures, no striking qualitative deviation has been found from the results obtained by other investigators using sintered polycrystalline material. It is therefore thought that small U_4O_9 precipitates which are distributed homogeneously in the UO_2 matrix (as shown by transmission electron microscopic observations) are responsible at very low temperature for the scattering of the phonons. The optical absorption edge (2.2 ev) measured at low temperature, seemed not to differ much from the one observed at room temperature. However, the spectrum itself shows much more structure. The elastic constant has been determined in one direction using a pulse echo technique. (auth)

4587 (GEAP-4739) ZIRCALOY-4 CLAD FUEL RODS FOR IRRADIATION IN THE VBWR. C. J. Baroch and S. J. Nowicki (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 1964. Contract AT(04-3)-189. 31p. Dep.(mn); $2.00(cy), 1(mn) OTS.

One of the "Special Fuel Assemblies" in the AEC Fuel Cycle Program, designated 6L, was designed and fabricated to test the irradiation performance of Zircaloy-4 cladding in a boiling water reactor. Material procurement problems were encountered during the fabrication of the fuel rods for the Special Assembly: The initial order of Zircaloy-4 tubing had to be rejected because the tubing exhibited excessive corrosion test weight gains and an unusual appearance after the standard production autoclave treatment. A second order of tubing was found to be acceptable. Nineteen fuel rods were fabricated using the acceptable tubing, and two fuel rods were fabricated using the rejected tubing. The two fuel rods using the rejected tubing were irradiated in the Vallecitos Boiling Water Reactor (VBWR) to determine whether the poor results observed in the autoclave treatment were indicative of the in-pile corrosion behavior. The irradiation in the VBWR of sixteen of these twenty-one fuel rods (fourteen from the acceptable tubing and two from the rejected tubing) in Assembly 6L began in April 1962. Irradiation of the assembly was scheduled to continue until an average burnup of at least 2.74×10^{20} fissions/cc (10,000 Mwd/t) had been achieved by some of the rods. However, the operation of the VBWR was terminated in December 1963, after an exposure of only 0.85×10^{20} fissions/cc (3091 Mwd/t) had been achieved. (auth)

4588 (MCW-1484) PROCESS DEVELOPMENT QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1964. (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). May 1, 1964. Contract W-14-108-eng-8. 29p. Dep.; $2.00(cy), 1(mn) OTS.

Developments are reported in electrolytic preparation of U metal, phase studies of U–Si–Fe systems, and preferred orientation studies. Separate abstracts were prepared for the three sections of the report. (J.R.D.)

For abstracts of individual sections see: 4589, 4651, and 4652.

4589 (MCW-1484(p.5-7)) PREPARATION OF URANIUM METAL BY FUSED SALT ELECTROLYSIS OF URANIUM DIOXIDE. R. D. Piper (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

Formation of well-coalesced U metal at current efficiencies up to 37% was realized in a laboratory cell by the use of a design that minimizes the back-reaction of CO with the metal and the use of a voltage control criterion that is the voltage observed on momentary interruption of the current. (auth)

4590 (MSAR-61-42) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report 7, March 1961. (MSA Research Corp., Callery, Penna.). Apr. 10, 1961. Contract AT(11-1)-765. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Various design aspects of the test loops were developed for the physical properties study. Design of the system and test specimens for the thermal shock studies were finalized. Analytical procedures for detecting carbon in sodium were investigated. (D.L.C.)

4591 (MSAR-61-105) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report 13, September 1961. (MSA Research Corp., Callery, Penna.). Oct. 10, 1961. Contract AT(11-1)-765. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The conditions for the fatigue study of stainless steel and 2¼ Cr–1 Mo steel in air and helium at 1200°F are discussed, and results are summarized for type 316 stainless steel for tests up to 600 cycles. The equipment for the fatigue, creep, and stress tests in sodium are discussed briefly. (D.L.C.)

4592 (MSAR-61-114) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report 14, October 1961. (MSA Research Corp., Callery, Penna.). Nov. 15, 1961. Contract AT(11-1)-765. 29p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The 100,000-cycle fatigue tests to date on type 316 stainless steel specimens in air using a 12-in. radius mandrel are summarized. The loops for fatigue, creep, and stress tests in sodium are illustrated. Test specimens for the thermal shock tests are discussed, and welding specifications for the dissimilar welds are included. (D.L.C.)

4593 (NLCO-926) GAMMA RADIOGRAPHY OF URANIUM METAL. B. L. Twitty and H. W. Humphrey (National Lead Co. of Ohio, Cincinnati). Sept. 28, 1964. Contract AT(30-1)-1156. 19p. (CONF-790-4). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 14th Annual Analytical and Physical Testing Symposium, Cincinnati, Oct. 1964.

The techniques and equipment used for the gamma radiography of uranium metal are described along with procedures for handling specimens of various thickness. The present gamma ray source is 15 curies of cobalt-60. In addition to gamma radiography, autoradiography (using the natural radiation of uranium itself as a source of gamma rays), radiography in color, and neutron radiography are discussed. (auth)

4594 (NP-14433) FURTHER DEVELOPMENT OF A DUCTILE TUNGSTEN-BASE SHEET ALLOY. Quarterly Progress Report No. 1, May 19–August 19, 1964. J. L. Ratliff, W. H. Abbott, D. J. Maykuth, H. R. Ogden, J. M. Blocher, Jr., and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). Sept. 19, 1964. Contract N600(19)-61982. 25p.

Scale-up feasibility was demonstrated for the W–5Re–2.2ThO_2 alloy. Starting with a thickness of ½ in., a section of this alloy was rolled at 1600°C through a total reduction of 92% to 0.040-in.-thick sheet. An evaluation of this sheet material showed a recrystallization temperature of 2000°C and 4T bend ductility at room temperature for the stress-relieved condition. Low temperature tensile tests on the alloy showed 12% elongation and 18% reduction of area at 0°C. Additional studies are also being conducted in an effort to develop improved techniques for dispersing thoria in W–5Re. As a separate part of this program, three selected forms of pyrolytic tungsten are to be evaluated as sheet material. Procurement and/or preparation of sheet bars of these is in process. (auth)

4595 (ORNL-3677) EVAPORATION OF IRON-, NICKEL-, AND COBALT-BASE ALLOYS AT 760 TO 980°C IN HIGH VACUUMS. D. T. Bourgette (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 38p. Dep.; $2.00(cy), 1(mn) OTS.

Evaporation rates of types 316, 304, and 446 stainless steels, Inconel, INOR-8, and Haynes alloy No. 25 were measured at pressures ranging from 5×10^{-7} to 1×10^{-9} torr in both the polished and oxidized conditions to determine their suitability for use in high vacuums. Evaporation losses increased with chromium and manganese concentration and temperature but were independent of pressure in the range investigated. The data have also shown that, at constant temperature, the evaporation rates decreased with time and that the lower the test temperature the greater the decrease in the rate. Metallographically, the manifestations of evaporation were subsurface void formation, grain growth at the specimen surface, excessive void formation in the grain boundaries, disappearance of precipitated phases, and materials loss from the edges of surface grains. Chemically, chromium and manganese were found to be the principal elements lost; however, lesser amounts of Fe, Ni, Co, C, and Si were found in the vapor deposits. Microprobe analysis revealed the existence of chromium and manganese concentration gradients that changed with time. At test temperatures of 872 and 982°C, it was found that a thin film of Cr_2O_3 (the most stable oxide studied) retarded the evaporation of the base alloy; however, the protection was not permanent. After approximately 1000 to 3000 hr, the evaporation rates for both the oxidized and polished surfaces of type 316 stainless steel were nearly equal. In the case of type 316 stainless steel, the alloy most thoroughly studied, the evaporation rates for the polished condition varied from 5.23×10^{-5} mg/cm²/hr at 760°C to 6.60×10^{-3} mg/cm²/hr at 982°C. While, for the oxidized condition (Cr_2O_3 film), the evaporation rates varied from 4.44×10^{-4} mg/cm²/hr at 872°C to 3.57×10^{-3} mg/cm²/hr at 982°C, at 760°C an oxidized specimen suffered no weight loss in 1142 hr. It was concluded that multicomponent alloys, unlike pure metals, evaporated nonlinearly with time and that this evaporation resulted in preferential loss of the higher vapor pressure elements. Further, these changes in composition may result in important changes in the physical and mechanical properties of the alloy. (auth)

4596 (RFP-433) A REVIEW OF METAL CLEANING BY ION BOMBARDMENT. J. R. Mullaly (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Dec. 2, 1964. Contract AT(29-1)-1106. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A literature survey was conducted on the cleaning of metal surfaces by ion bombardment. Most of the surveyed research dealt with the determination of yield and with surface effects. Problems which might be involved in cleaning operations were studied. (D.L.C.)

4597 (SAN-8003(p.13-89)) FUELS AND MATERIALS. (San Francisco Operations Office, AEC).

Separate papers include: operating experience from BORAX V central superheater fuel; superheat fuel cladding development at ANL; failures of type 304 SS tubing in superheater environment; development and testing of fuel for the Advanced BONUS Core; nuclear and thermal characteristics of the BONUS multitube fuel elements; ESADE performance and fuel assembly ESH-1.1 irradiation testing; superheat fuel element development for EVESR; core design for FSPPR fast breeder superheat reactor; metallurgical evaluation of superheat fuel cladding; irradiation testing of nickel-base alloys for high-temperature reactor structures; post-irradiation evaluation of Hastelloy X clad fuel element; and strain-cycle effects in thin-wall tubing for fuel element applications. (R.E.U.)

4598 (UCRL-Trans-1135(L)) FUSION OF POWDERS IN A PLASMA JET. H. Meyer. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Ber. Deut. Keram. Ges., 41: 112-19(1964). 17p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

An experimental study was made of the melting of powders in a plasma jet. Powders of glass, oxides, and metals were used. The formation of hollow spheres is discussed. The possible formation of nitrides by melting of oxides in a nitrogen plasma is pointed out, and the use of rare gases as the plasma gas for the spraying of oxides is recommended. (D.L.C.)

4599 NUCLEAR PHYSICS METHODS IN METAL PHYSICS. Karl Lintner (Universität, Vienna). Acta Phys. Austriaca, 18: 116-45(1964). (In German)

The uses of neutron scattering, nuclear magnetic resonance, the Mössbauer effect, and corpuscular irradiation in metallographic studies are described on the basis of some pertinent examples. (J.S.R.)

4600 REPORTS FROM THE GENEVA CONFERENCE. III. NUCLEAR MATERIALS AND FUELS. Jean Pheline. Ind. At., 8: Nos. 9-10, 68-78(1964). (In French)

The chief contributions of the various countries are summarized, and attention is called to a few salient points in the discussions held during the sessions of the Geneva Conference dealing with problems of materials and fuels. The interest of the data presented is better measured by the enormous amount of work needed to build up the background of knowledge accumulated since 1958 than by any revelations of a sensational nature. Thanks to the progress and refinements worked out in the various fields and despite certain difficulties which are emphasized, it can be expected that satisfactory technical and economical performances can be obtained from existing materials to take care of the present generation of reactors and of those in the near future. Important improvements can be anticipated for ensuing generations. (tr-auth)

4601 THIN FILMS OF NIOBIUM TIN BY CODEPOSITION. C. A. Neugebauer (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 35: 3599-3603(Dec. 1964).

Thin films of niobium–tin were deposited by the simultaneous condensation of niobium and tin vapor from two separate evaporation sources in a vacuum system. The composition and structure of the deposit was examined as

a function of substrate temperature and the relative impingement rate of niobium to tin. If this rate ratio is near 3:1, the cubic phase Nb_3Sn is the predominant product, regardless of substrate temperature, even if it is much below the temperature where Nb_3Sn forms in the bulk. For a ratio of 3:2, and at substrate temperatures less than 800°C, formation of Nb_3Sn is almost entirely suppressed, and phases higher in tin predominate. Annealing at 900°C converts the phases high in tin to Nb_3Sn. The superconducting critical temperature of codeposited niobium tin films is below 14°K before annealing and above 14°K after annealing at 900°C. The superconducting energy gap is the order of 1 Mev at 4.2°K, considerably below the value predicted by the BCS theory. This suggests that the material on the surface of the films has a lower critical temperature than in the interior. (auth)

4602 SEDIMENTATION ANALYSIS WITH X-RAYS OR BREMSSTRAHLUNG. H. Ramdohr and W. Kuehn (Isotopen-Studiengesellschaft e.V., Frankfurt am Main). Kerntechnik, 6: 416-18(Sept. 1964). (In German)

A method and experimental setup for particle-size measurement in pulverized solids is described. The absorption of x rays or bremsstrahlung is used for solid-concentration determination in a sedimentation medium. The adjustment of the radiation energy to the element composition of the solid allows the measurement of solids containing certain elements such as Fe to be carried out with high sensitivity by using the K absorption edge. The method is illustrated by measuring the particle-size distribution of Fe_2O_3 powder in a laboratory test. (auth)

4603 ULTRASONIC ATTENUATION IN PARAMAGNETIC AND ANTIFERROMAGNETIC UO_2. M. R. Daniel and C. T. Walker (Northwestern Univ., Evanston, Ill.). Phys. Letters, 13: 200-2(Dec. 1, 1964).

Results of ultrasonic attenuation measurements in UO_2 are reported. These measurements, made over the range 4.2–300°K, demonstrate what seems to be a new phenomenon; namely, the ultrasonic attenuation oscillates as a function of temperature. The oscillations start at 4.2°K and continue to be observable up to 220°K. Above the Néel temperature, in the paramagnetic region, the attenuation is periodic in T^{-1}; below T_N the attenuation is periodic in a negative fractional power of $|T_N - T|$. (C.E.S.)

4604 ELECTROLYTIC COATING WITH RARE METALS AND THEIR ALLOYS. S. I. Sklyarenko and I. I. Lavrov. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 8: 530-7(1963). (In Russian)

A review of data on Be, In, Ga, Tl, Ge, Ti, Zr, V, Nb, Ta, Mo, W, Re, and their alloys for electrolytic and electroless plating of parts such as Cu and Ag bearings or steel drawing dies is presented. Optimum compositions of electrolytes (aqueous, salt solutions, and organic solvent-base electrolytes) and electroplating conditions are given. Corrosion and friction resistivity of the plated parts are discussed. 123 ref. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4605 ELECTROLYTIC COATING OF LIGHT METALS AND REFRACTORY METALS AND THEIR ALLOYS. V. I. Layner. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 8: 538-44(1963). (In Russian)

A review is presented on the protective coating techniques for Al, Mg, and Ti alloy wires and castings, including surface preparation, chromizing and electrolytic Ni-plating, Cr-plating, and Ag-plating using Zn or Cu sublayers. The review includes prevailing techniques in protection coating of Mo, W, Nb, and Ta and their alloys, including surface etching and Cr and Ni plating. High-temperature corrosion resistance, acid corrosion resistance, adhesion of coatings, and wear resistance of coated lightweight metals and refractory metals are discussed. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4606 IMPROVEMENTS IN AND RELATING TO CARBONIZATION. Charles Vernon Mitchell (to Union Carbide Corp.). British Patent 968,215. Sept. 2, 1964. Filed July 21, 1961.

A process is given for producing high-purity graphite from polynuclear aromatic hydrocarbons without the use of catalysis or high pressure. The process comprises heating acenaphthylene, decacyclene, or naphthacene in an inert atmosphere at 1 atm pressure to 350–400°C at a rate of 10–100°C/hr and maintaining the temperature for 1–15 hr; increasing the temperature to 450–500°C and maintaining the temperature for 1–10 hr; cooling the resulting coke material; heating again to 800–1000°C and maintaining the temperature until complete calcination is effected; and graphitizing the calcined coke. Variants of the process are described. Data are given on the coking values of various polynuclear aromatic hydrocarbons and on the properties of the resulting graphites. (D.L.C.)

4607 METHOD OF MANUFACTURING SINTERED METALLURGICAL PRODUCTS. Roger Biais, Jacques Hoghen, Jean Herenguel, Pierre Lelong, and Jacques Moisan (to Commissariat à l'Énergie Atomique). British Patent 968,476. Sept. 2, 1964. Priority date June 19, 1961, France.

A powder metallurgical method is given for manufacturing sintered metals and alloys which have a homogeneous structure and an increased stability at high temperatures. In the method, a metal powder is subjected to a physical or chemical treatment to form on the particle surfaces a film which prevents diffusion; the treated powder is gradually heated in vacuum to degas the powder and eliminate any gasifiable inclusions; the powder is compressed in the hot state; and finally the product is shaped by plastic deformation. The method is described with reference to the producting of Al alloys using Fe–Ni as the diffusion barrier. Data are given on the corrosion of the resulting products by water at 350°C and steam at 450°C. (D.L.C.)

4608 PROCESS FOR THE MANUFACTURE OF VERY PURE CRYSTALLINE CARBIDES, NITRIDES, OR BORIDES. (to Wacker-Chemie GmbH). British Patent 968,590. Sept. 2, 1964. Priority date Oct. 8, 1959, Germany.

A process is given for preparing very pure crystalline carbides, nitrides, or borides of elements of groups 3 to 6 of the Periodic System. The process comprises subliming the carbide, nitride, or boride from a carrier on to a condensation element while a temperature fall of 1 to 2000°C is maintained between the carrier and condensation element. An apparatus is described for carrying out the process, and examples of the process are given in which pure silicon carbide and boron nitride were prepared. (D.L.C.)

4609 METHOD AND APPARATUS FOR PRODUCING SINGLE CRYSTALS OF REFRACTORY MATERIAL. (to Centre d'Étude de l'Énergie Nucléaire). British Patent 968,785. Sept. 2, 1964. Priority date Dec. 29, 1961, Netherlands.

A method is given for producing single crystals of a refractory material with a high melting point. In the method, a channel-shaped recess is formed in a body of the material, the body is located in a controlled medium, and an electric current is passed into the body to bring the recess wall to the sublimation temperature. The electric current is passed into the body by means of two electrodes which close the recess and which are cooled so that single crystals of the body material are condensed on their surfaces. An apparatus and the application of the method to UO_2 are described. (D.L.C.)

4610 IMPROVEMENT IN OR RELATING TO THE PRODUCTION OF A NUCLEAR FUEL MATERIAL. Neville Ronald Williams (to United Kingdom Atomic Energy Authority). British Patent 968,941. Sept. 9, 1964. Filed July 20, 1962.

A method is given for producing spheroids of the mixed carbides of uranium and thorium for use in matrix fuels for the Dragon Reactor. The method comprises the steps of milling together powders of C, UO_2, and ThO_2 and/or Th metal in an inert organic liquid, removing excess liquid to form a cake, drying the cake under vacuum at low temperature, granulating the cake, gyrating the granules in contact with an abrasive track, and heating the resulting green spheroids to induce reaction between the constituents. The powders which are milled should not contain more than 0.1% water. (D.L.C.)

4611 A METHOD OF PRODUCING A GLASS OBJECT HAVING A SYSTEM OF STRESSES THEREIN. (to Compagnie de Saint-Gobain). British Patent 969,012. Sept. 9, 1964. Priority date Jan. 8, 1960, France.

A method for producing a glass object with internal stresses is given which is based on nonuniform radioinduced dimensional changes. The method comprises subjecting the glass to a thermal neutron flux in such a way so that the surface zone receives a larger dose than the internal zone. The reaction that usually occurs is the (n,α) reaction of boron and/or lithium, although another neutron-absorbing element may be added to the glass. Typical glass compositions which expand or contract when irradiated are given, and some typical stress distributions produced by the method are described. (D.L.C.)

4612 ZIRCONIUM ALLOY. Ulrich Roesler (to Siemens-Schuckertwerke AG). U. S. Patent 3,150,972. Sept. 29, 1964. Priority date Dec. 27, 1961. Germany.

Zr alloys containing Nb, Ca, and other elements and offering improved corrosion resistance in superheated steam up to 400 and 500°C are described. The preferred composition is 0.3 to 2.5% Nb and 0.01 to 0.5% Ca with one or more of the following: 0.2 to 1% Sn, 0.1 to 1.5% Fe or Cr or Ni, 0.5 to 1% Mo, 0.5 to 1.5% Cu, 0.5 to 1% W, or 0.2 to 1% V. (T.R.H.)

Corrosion

Refer also to abstract 4197.

4613 (BW-67-3) THE COMBINED EFFECTS OF A SODIUM ENVIRONMENT AND EXTENDED LIFE ON TYPE 316 STAINLESS STEEL AND CROLOY 2-¼ ALLOY STEEL DESIGN STRESSES. SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. R. C. Anstine (Babcock and Wilcox Co., Barberton, Ohio). Sept. 1964. Contract AT(11-1)-1280. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Design stress curves based on limited data are presented for Type 316 stainless steel and Croloy 2¼ alloy steel in a sodium environment and for an operating life of 30 years. These design stress curves can be used for the safe design of sodium-heated steam generators and other sodium components until further data become available. (auth)

4614 (CONF-654-23) SAVANNAH RIVER PLANT EXPERIENCE WITH TYPE 304 STAINLESS STEEL IN HEAVY WATER COOLED REACTORS. S. P. Rideout, W. C. Rion, Jr., and J. W. Wade (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Nov. 19, 1964. Contract AT(07-2)-1. 25p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Experience has shown that type 304 stainless steel is a satisfactory material of construction for water-cooled reactors provided the steel is not abused by severe sensitization and over pickling. Nitric-hydrofluoric acid is particularly harmful to sensitized type 304 steel. Damage to the steel during initial fabrication occurred as a result of efforts to achieve ultra clean surfaces. The general intergranular attack on the surfaces of sensitized material rendered it extremely susceptible to chloride stress corrosion cracking in an environment that normally does not cause such damage. No stress corrosion has been found in unsensitized metal. (auth)

4615 (EURAEC-1115) FURTHER DEVELOPMENT OF THE ZIRCONIUM ALLOY ZrNb3Sn1 WITH A VIEW TO ITS APPLICATION AS JACKETING MATERIAL IN WATER-COOLED NUCLEAR REACTORS. Quarterly Report No. 3, April 1–June 30, 1964. (Metallgesellschaft A. G., Frankfurt am Main). July 7, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 019-63-11-TEED. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Alloys of the type ZrNb3Sn1 with small additions of Cr, Fe, Ge, Cu, Sb, Te, and V were examined in comparative corrosion experiments in superheated steam at 400 and 450°C. After 1000 hr in superheated steam at 450°C the following alloys show considerably lower corrosion than the alloy ZrNb3Sn1: ZrNb 2.78 Fe 0.1; ZrNb 2.78 Sn 0.3 Fe 0.1; ZrNb 2.78 Sn 1 Fe 0.1; ZrNb 1.90 Sn 1 Fe 0.5; ZrNb 2.34 Cu 0.2; ZrNb 2.34 Sn 0.6 Cu 0.2; ZrNb 1.74 Cr 0.5; ZrNb 2.56 V 0.1 Sn 0.3; ZrNb 2.04 Sb 0.2; and ZrNb 2.04 Sb 0.2 Sn 0.3. Large cast ingots were smelted from these alloys and prepared as test material for more thorough corrosion experiments and for mechanical examination. During the period under review a start was made with tensile tests at room temperature and at 450°C, as well as with creep test experiments at 450°C. The stress in the creep tests was 3 and 4.5 kg/mm² respectively. (auth)

4616 (EURAEC-1161) EXAMINATION OF ZIRCONIUM HYDRIDE IN ZIRCALOY 2 AND ZrNb ALLOYS. Final Report No. 1, October 1, 1961–December 31, 1963. (Siemens-Schuckertwerke A. G., Erlangen, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 024-61-10-RDA. 61p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Results of tests on Zircaloy-2 and ZrNb alloys are presented. The alloys were subjected to steam and high-temperature water to determine corrosion rates and hydridation. Results of mechanical tests and metallographic examinations are included. (J.R.D.)

4617 (IS-888) COMPATIBILITY STUDIES OF SEVERAL MOLTEN URANIUM AND THORIUM ALLOYS IN NIOBIUM, TANTALUM, AND YTTRIUM. Robert James Cash, Ray M. Fisher, and Merl R. Core (Ames Lab., Ames, Iowa). Feb. 1964. Contract W-7405-eng-82. 151p. Dep.; $5.00(cy), 3(mn) OTS.

Niobium, tantalum, yttrium, and Inconel have been used to contain molten aluminum, lead, tin, zinc, and several of their respective uranium and thorium alloys for various times up to 3000 hours and at temperatures ranging from 600 to 1100°C. Altogether 76 capsule tests were run, almost all in a static isothermal condition. Tantalum showed the best resistance followed by niobium, Inconel, and yttrium respectively. The systems, lead in tantalum and lead in niobium, showed the greatest potentials for possible liquid-metal fuel carrier systems. An alloy of uranium–bismuth–tin contained in tantalum also exhibited promising possibilities. The tabulated test data include a classification of the type of corrosion attack which occurred and a measured value of the amount of corrosive penetration. Each test was also given an arbitrary rating for easy reference comparisons. A number of photomicrographs are included for each set of tests. A background of the advantages and disadvantages of fluid-fuel reactors are compared with those for solid-fuel reactors. Differences between aqueous fuels and liquid-metal fuels are also discussed. The various types of corrosive attack of solid metals by liquid metals are defined and illustrated with several photomicrographs. The variables affecting liquid-metal corrosion attack are given and driving forces for the various types of attack presented. Methods of corrosion inhibition are mentioned. The various criteria for selecting fuel and fertile alloys and suitable container materials were also considered. (auth)

4618 (MSAR-61-60) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report 8, April 1961. (MSA Research Corp., Callery, Penna.). May 10, 1961. Contract AT(11-1)-765. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The fabrication of the test loops and other equipment is discussed. In the thermal shock test program, the carbon background in the Van Slyke oxidizing solution and the C and O contents in the sodium were studied. (D.L.C.)

4619 (MSAR-61-67) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report 9, May 1961. (MSA Research Corp., Callery, Penna.). June 9, 1961. Contract AT(11-1)-765. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The fabrication and status of loop components, equipment, etc., are described. Sampling of the small sodium

pot gave a decrease of carbon concentration which is linear with time. (D.L.C.)

4620 (MSAR-61-100) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report 12, August 1961. (MSA Research Corp., Callery, Penna.). Sept. 11, 1961. Contract AT(11-1)-765. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A description is given of the status of the equipment for the Physical Property Study of stainless steel and 2¼ Cr–1 Mo exposed to sodium at 1200°F. The creep-stress and fatigue pots and the test loops are described. (D.L.C.)

4621 (MSAR-62-142) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 26, October 1962. (MSA Research Corp., Callery, Penna.). Nov. 14, 1962. Contract AT(11-1)-765. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Data are tabulated for the fatigue, stress rupture, creep, and tensile tests of type 316 stainless steel at 1200°F and 2¼ Cr–1 Mo steel at 1100°F in air, helium, and sodium. Analysis of loop specimens and sodium, and metallurgical examinations of steel specimens are also reported.(D.L.C.)

4622 (MSAR-62-159) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 27, November 1962. (MSA Research Corp., Callery, Penna). Dec. 14, 1962. Contract AT(11-1)-764. 29p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Data are tabulated and shown graphically for all the tests completed and in progress: fatigue, tensile, creep, and stress-rupture tests for Type 316 stainless steel (1200°F) and 2¼ Cr–1 Mo steel (1100°F) in air, helium, and sodium. The operational histories of Loops 1 and 2 are described. Analysis of sodium in the loops for carbon and oxygen is discussed. (D.L.C.)

4623 (MSAR-63-6) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 28, December 1962. (MSA Research Corp., Callery, Penna.). Jan. 15, 1963. Contract AT(11-1)-765. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Data from all the tests completed and in progress are summarized in table and graphic form: fatigue, tensile, creep, and stress-rupture tests of type 316 stainless steel (1200°F) and 2¼ Cr–1 Mo steel (1100°F) in air, helium, and sodium. The operation of the loops in the tests are discussed briefly. Analysis of sodium samples for carbon and carbonate is reported. Metallurgical examination of steel specimens and their carbon content after exposure to sodium are discussed. (D.L.C.)

4624 (MSAR-63-75) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 32, April 1963. (MSA Research Corp., Callery, Penna.). May 10, 1963. Contract AT(11-1)-765. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The current status and some progress of the various tests on Type 316 stainless steel and 2¼ Cr–1 Mo steel are reported. The calibration of a creep machine is described. Results are given of carbon analyses of sodium samples from Loop 2. Carbon solubility studies indicate a segregation of particulate carbon in the sample tube. Carbon analysis results and microhardness observations are given for fatigued Type 316 stainless steel and 2¼ Cr–1 Mo specimens. (D.L.C.)

4625 (NDA-14-22) CORROSION OF SPECIAL FUEL ALLOY IN SODIUM AT 1000°F. B. Minushkin (Nuclear Development Associates, Inc., White Plains, N. Y.). Dec. 31, 1953. For Detroit Edison Co., Detroit and Dow Chemical Co., [Midland], Mich. 16p.

Two corrosion harps were set up to study the corrosion in high-temperature sodium of a special fuel alloy supplied by Battelle Memorial Institute. In addition five stainless steel tabs were inserted at the bottom of each harp in the cold zone. The special fuel alloy samples along with the 10 stainless steel tabs and 100 grams of sodium (as NaOH) from each harp were submitted for closer inspection and analysis of corrosion and radioactive pickup. From fluorimetric analysis of the stainless steel tabs and the sodium (in the form of NaOH) it appears that: (1) There is very little uranium deposition on the surface of the stainless steel tabs. The maximum deposition is about 0.03 to 0.1 $\mu g/cm^2$ except for one tab which showed a deposit as high as 9 $\mu g/cm^2$. (2) The samples from harp No. 2 (greater temperature gradient) showed greater surface deposition of uranium than the samples from harp No. 1. (3) The sodium from the harps contained less than 50 ppm dissolved uranium. (4) Microscopic examination of the sectioned and polished fuel alloy samples revealed that there was detectable attack on the surface of these samples. (auth)

4626 (SC-RR-64-575) EXPERIMENTAL INVESTIGATION OF TANTALUM OXIDATION IN SIMULATED REENTRY. G. E. Clark and B. W. Marshall (Sandia Lab., Albuquerque, N. Mex.). July 1964. Contract AT(29-1)-789. 36p. Dep.; $2.00(cy), 1(mn) OTS.

An initial experimental study was conducted on tantalum oxidation in simulated reentry conditions. The tests were performed in a hyperthermal arc-powered tunnel on 36 models, half of which were exposed to one enthalpy condition and half to another. The oxygen flow in the oxygen–nitrogen mixture was varied from 0 to 21 percent in order that the effects of several different oxygen flow rates might be examined. The surface temperature of the model was continuously monitored with a radiation pyrometer, and surface phenomena were photographed on high-speed 16-mm color film. Models exposed to pure nitrogen experienced no surface melting, whereas all the models exposed to oxygen flows, with the same enthalpy and pressure, melted. The length of time required to initiate surface melting and the rate at which the surface regressed was found to be related to oxygen flow. Surface recession under these conditions results from the formation and subsequent melting of one or more oxides — possibly tantalum pentoxide (Ta_2O_5), since measurements of the surface temperature of the models at the time of melting showed very satisfactory correlation with the melting temperature of Ta_2O_5 (1870°C) as reported in several references. Thus, analysis of the response of tantalum under reentry conditions involves surface temperature, surface oxygen flux, and time of reentry, rather than the possibility of melting tantalum metal at 2980°C. (auth)

4627 THE GROUP FOR STUDY OF AQUEOUS CORROSION AND ELECTROCHEMISTRY. H. Coriou. Bull. Inform. Sci. Tech. (Paris), No. 84, 17-35(June 1964). (In French)

Experimental techniques involved in the research of the "Service d'Etude de la Corrosion Aqueuse et d'Electrochimie" are reviewed. The ways in which they are put into practice in the laboratories are discussed and several examples are proposed. The latest investigations and results are summarized. A bibliography of recently printed articles is given. (auth)

4628 BEHAVIOR OF VERY PURE ZIRCONIUM IN DEMINERALIZED WATER AND STEAM AT HIGH TEMPERATURE. Henri Coriou, Lucien Grall, Maurice Pelras, and Marc Salesse (Commissariat à l'Énergie Atomique, Saclay, France). Compt. Rend., 259: 1862-5(Sept. 14, 1964). (In French)

An extensive purification of zirconium acts unfavorably on the behavior of the metal in demineralized water at 360°C and especially in superheated vapor at 400°C. The addition of iron reduces the corrosion considerably. (tr-auth)

4629 THE INFLUENCE OF STEEL TEMPERATURE AND COMPOSITION ON CORROSION RESISTANCE. Georgi Illinčev. Jaderna Energie, 10: 271-81(Aug. 1964). (In Czech.)

Results of steel investigations in streaming sodium with an oxygen content of 1 to 3×10^{-3}% at the temperatures of

450, 600, and 750°C are reported. The 1,500-hr corrosion tests were carried out either on forced circulation sodium loops or on heat convection loops. A convection loop with controlled parameters for high-temperature corrosion tests is described. Corrosion resistance was investigated for 30 types of low and medium alloyed steels. for low-carbon Mo, W, and Cr alloyed steels, stabilized with Ti or Nb, for Cr and Cr–Ni anticorrosion steels, and for Ti and Ni steels. The dependence of steel corrosion on temperature is given. The influence of Cr and Ni is discussed. Corrosion resistance was evaluated after weight changes, metallographic investigation, and mechanical property changes. (auth)

4630 CORROSION OF STAINLESS STEEL BY LIQUID METALS. B. C. Agrawal. Trans. Indian Inst. Metals, 16: 184-7(Sept. 1963).

The use of liquid metals as heat transfer fluids in nuclear power reactors is discussed. Investigations on the effects of liquid Pb and Bi on 18-8 stainless steel showed that corrosion of the steel is due to leaching of Ni by liquid Bi and of both Ni and Cr by liquid Pb. The interaction takes place above 500°C. (Rev. Metal Lit., 21: No. 11, Nov. 1964).

Fabrication

Refer also to abstract 4477.

4631 (ANL-6806) DEVELOPMENT OF TECHNIQUES FOR FABRICATION OF SMALL-DIAMETER THIN-WALL TUNGSTEN TUBING. Interim Progress Report, July 1–December 31, 1963. W. R. Burt, Jr., H. C. Katiyar, and R. M. Mayfield (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 35p. Dep.; $2.00(cy), 1(mn) OTS.

Tungsten tubes suitable for secondary fabrication were extruded from various starting materials. Pressed and sintered sleeves, vapor-deposited tubes, and pre-extruded tubes were successfully extruded. In addition, consolidation and extrusion of high-purity W powder in a single extrusion show promise. Various starting materials are being evaluated on the basis of obtaining good fabricability and properties, as well as providing a more economical means of producing high-quality tubing. Secondary fabrication will start after hot-swaging dies and other warm-working equipment have been received. Warm-working is necessary because the ductile/brittle transition temperature of W is above room temperature. Equipment, extrusion techniques, and results are described, along with plans for future work. (auth)

4632 (DMIC-Memo-195) THE PRODUCTION OF POWDER-METALLURGY TUNGSTEN SHEET AND PLATE. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). July 20, 1964. Contract AF33 (615)-1121. 9p. (AD-606053). $1.00(OTS).

A review and analyses are presented of the W sheet rolling program performed by the Fansteel Metallurgical Corporation. Emphasis is placed on detailing the procedures which were evolved for the production of 113 plates and sheets of various gages. These materials are now being evaluated for physical and mechanical properties as well as for formability characteristics on three other Navy programs. (auth)

4633 (DP-889) ATTACHING FUEL ASSEMBLY RIB SPACERS BY ELECTRON BEAM WELDING. Lawrence J. Scott (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). June 1964. Contract AT(07-2)-1. 44p. Dep.; $2.00(cy), 1(mn) OTS.

Methods were developed for attaching rib-shaped spacers to nuclear fuel elements and housings by means of electron beam welding. Zircaloy ribs of various sizes were welded to the outside of tubes containing metallic uranium fuel. Also, ribs were attached to the inside and outside of thin-wall Zircaloy tubes to form fuel element housings. Weld quality was judged by examining weld sections and by conducting corrosion and mechanical property tests. Full-size ribbed housings were charged to the Heavy Water Components Test Reactor. (auth)

4634 (EURAEC-1098) SURVEY OF ELEMENTARY CRACKING. PRELIMINARY QUALIFICATIVE SURVEY OF THE OPERATIVE METHOD OF WELDING. Quarterly Report No. 6, April 1–June 30, 1964. (Institut de Soudure, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 090-62-12-RDF. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results in work devoted to a survey of elementary cracking are reported. Scanning the hardness of the beads deposited by welding under flux and by the MIG process was concluded, and cracking tests by welding with coated electrodes were completed. The welding thermal cycle of the last two processes was studied. By collating the data for each welding process, interpretation of the results to prepare them for presentation in the over-all final report was initiated. (auth)

4635 THE BRAZE BONDING OF CERMET NUCLEAR FUELS. L. H. Cope, P. W. Jackson, and B. J. S. Wilkins (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Metallurgia, 70: 153-8(Oct. 1964).

A braze-bonding route was developed for bonding 50 vol % fissile oxide–316L stainless steel cermets to 316L stainless steel cans. Good metallurgical bonds were obtained over the full length of cermet fuel pins of up to at least 12 in. long. The process was also adapted for the internal brazing of stainless steel thermocouple sheaths along the axes of cermet fuel pins, which provides a means of measuring directly the in-pile center temperature of a cermet fuel pin. (auth)

4636 CHILL EFFECT ON CAST URANIUM 8.5 PER CENT MOLYBDENUM PLATES. R. V. London and R. E. Edelman. Mod. Castings, 45: 233-7(May 1964).

Uranium–8.5% Mo plates were investment cast in a vacuum induction furnace using a bottom pour technique. Three plates were chill cast while one remained unchilled. Specimens machined from the plates were tensile tested. Ductility and grain size determinations were made. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4637 MACHINING THE REFRACTORY ALLOYS. Norman Zlatin. Western Machinery Steel World, 55: No. 4, 28-31(Apr. 1964).

Machining characteristics of tungsten, pressed and sintered to 93% density, D-31 Nb alloy, TZM Mo alloy, and 90 Ta-10W Ta alloy are discussed. Charts are given to compare these metals with other aerospace alloys with respect to relation between tool life and cutting speed. Recommendations for turning, face milling, drilling, tapping and grinding are made. (Rev. Metal Lit., 21: No. 11, Nov. 1964).

4638 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF GRAPHITE. Michael Stuart Thomas Price, Thomas Rhys Jenkins, and Brian Longstaff (United Kingdom Atomic Energy Authority). British Patent 970,591. Sept. 23, 1964. Filed May 30, 1961.

A process for making extrudable graphite capable of yielding highly impermeable reactor parts is described. A mixture of 42 wt.% coarse graphite (50 to 100 μ), 18 wt % fine graphite (5 to 20 μ), and 40 wt % carbon black (0.4 μ) with a binder is extruded, then carbonized at 900°C, then graphitized at 2700°C. Tubes thus prepared with walls ¼" thick were twice impregnated with furfuryl alcohol and heat treated at 2000°C to produce a permeability to Kr at 25°C of 10^{-7} cm²/sec. (T.R.H.)

4639 IMPROVEMENTS IN OR RELATING TO METALLURGICAL PROCESSES. Alan Moore and Frederick Morrow (to United Kingdom Atomic Energy Authority). British Patent 974,695. Nov. 11, 1964. Filed Sept. 19, 1961.

Alloys of Be with Mn or Cr or Ti, of improved ductility are described. The binary alloy is heated so that the Mn, Cr, or Ti migrates to the gram boundaries and forms a Be compound. The heating temperature is not above 1000°C at 0.12 wt. % Mn or Cr, 980°C at 0.08 wt. %, 950 at 0.04 wt. %, 800°C at 0.03 wt. % and 600°C at 0.02 wt. %. The heating times are 3000 min at 600°C, 300 min at 700°C, and 60 min at 800°C. (T.R.H.)

4640 IMPROVEMENTS IN OR RELATING TO REFRACTORY PRODUCTS. Andre Accary, Jacques Molinari, and Michel Marchal (to Commissariat à l'Énergie Atomique). British Patent 974,807. Nov. 11, 1964. Priority date June 13, 1960, France.

A procedure for preparing refractory uranium nitride-containing fuel compact is described. Very pure N_2 reacts with U powder at 800°C to produce nitride of N/U ratio about 1.6. The nitride is mixed with U powder (65.15g and 36.45g, respectively) and sintered in graphite at 250 kg/cm^2 to reach 1000°C in 3 hours. This temperature was maintained for 4 hours. The product was pure UN. (T.R.H.)

4641 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Edwin Davis and Stanley Fenemore (to United Kingdom Atomic Energy Authority). British Patent 974,887. Nov. 11, 1964. Filed Oct. 11, 1961.

A method of finned Mg-alloy-clad fuel element fabrication is described. The fuel is inserted in a plain tube, and end-caps are welded on. The assembly is machined to the proper dimensions and then fin-rolled to produce fins and secure the cladding to the fuel. (T.R.H.)

4642 IMPROVEMENTS RELATING TO THE BONDING OF METAL CLADDING TO A CERMET BODY. John Llewellyn Evans (to United Kingdom Atomic Energy Authority). British Patent 975,213. Nov. 11, 1964. Filed Nov. 22, 1962.

A method of bonding a UO_2-stainless steel cermet to a stainless steel cladding is offered. The cermet is impregnated with Cu and put into the cladding lined with Cu foil. The assembled element is compressed at 20 tons/in.^{2} and brazed internally by heating at 1110°C for 5 minutes. (T.R.H.)

4643 METHOD FOR PREPARATION OF URANIUM DIOXIDE WITH A SMOOTH SURFACE AND A SPHERICAL SHAPE. Marie Egidius Antonius Hermans and Theo van der Plas (to Reactor Centrum Nederland). German Patent 1,171,890. June 11, 1964. Priority date Sept. 18, 1959, [Netherlands].

A method is described, which enables the direct production of a granulated fissionable material, e.g., to be used in suspensions, which has a predetermined grain size and a spherical shape. Concentrated ammonium sulfate is added to a solution of an uranyl salt to which ammonia was previously added, in such a way that the pH value is kept at critical value between 2 and 3. The precipitate is separated and turned into a solid material with the help of a watery ammonia solution. The solid material is then dried and reduced. (Gmelin Inst.)

Properties and Structure

Refer also to abstracts 4760, 5092, 5125, and 5187.

4644 (ASD-TDR-62-509(Vol.III)) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. (Nuclear Metals, Inc., West Concord, Mass.). July 1964. Contract AF33(616)-7065. 94p. (AD-606667). $3.00(OTS).

Work primarily concerned with effects of grain size and purity of Be is reported. The efforts to produce the purest Be by double vacuum distillation are reported. The distilled Be when converted to powder and subsequently extruded exhibits greater bend ductility than any less pure Be utilized in the evaluation. The ductility and critical resolved shear stress for basal slip of cast single crystals of Pechiney SR grade and single distilled was evaluated. The data were compared with previous work on cast commercial grade and zone-refined single crystals. Work aimed at achieving finer grain-size powder and minimizing contamination is also reported. Powder of particle sizes less than 5 microns was produced by improved attritioning methods. The attainment of powder sizes of approximately 300 angstroms by evaporation and condensation is described and consolidation and evaluation of these powders is discussed. The hot pressed powder has exceptionally high hardness and is very brittle, prohibiting the preparation of mechanical test specimens. (auth)

4645 (ASD-TDR-62-509(Vol.IV)) A STUDY OF THE BRITTLE BEHAVIOR OF BERYLLIUM BY MEANS OF TRANSMISSION ELECTRON MICROSCOPY. F. Wilhelm and H. G. F. Wilsdorf (Franklin Inst., Philadelphia). July 1964. Contract AF33(616)-7065. 60p. (AD-606666). $4.00 (OTS).

Glide dislocations in Be specimens were studied by direct observation with an electron microscope. The procedures are described by which specimens were heat treated and deformed as well as the technique used to obtain electron-transparent specimens from bulk Be. Investigations made on polycrystalline Pechiney flake Be, on commercial-purity single crystal plates, and on high-purity single crystal tensile specimens are described. Glide dislocations in Be are strongly hindered in their movements and are often pinned by lattice imperfections and larger precipitate particles, especially in Be of commercial purity. Dislocation tangles were observed in deformed Pechiney flake Be and in crystals of commercial purity; the presence of round as well as elongated prismatic dislocation loops is in evidence. Dislocations of different slip systems may react to form incipient networks. In specimens where dislocation pinning is less pronounced, dislocations have a tendency to align themselves along crystallographic directions. In high purity tensile specimens, dislocation bundles of high density are found to lie in the basal plane in a $(1\bar{1}00)$ direction perpendicular to the principal glide direction. Many of these dislocations are dipoles. It is found that most dislocation reactions are confined to relatively thin glide packets parallel to the basal plane. Rarely have dislocation motions been observed under the stress created by a high-intensity electron beam in the microscope. A high Peierls-Nabarro force as well as high stacking fault energy in Be is concluded. An inference is drawn with regard to the brittleness problem of Be. (auth)

4646 (AWRE-O-70/64) A STUDY OF THE HANDLING, THE MECHANICAL PROPERTIES AND CRYSTAL STRUCTURE OF SILICON NITRIDE WHISKERS. C. A. Calow and B. Begley (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Sept. 1964. 13p. Dep.(mn).

The separation of individual whiskers from the original whisker wool, the metallizing of whiskers with Ni and Ag, tensile testing, and x-ray structure are described. (auth)

4647 (CEA-R-2531) COMPARAISON DES ALLIAGES U–Pu–Mo, U–Pu–Nb, U–Pu–Ti, U–Pu–Zr. (Comparison of U–Pu–Mo, U–Pu–Nb, U–Pu–Ti, and U–Pu–Zr Alloys). René Boucher and Pierre Barthelemy (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). July 1964. 36p. Dep.(mn).

The data concerning the U–Pu, U–Pu–Mo, and U–Pu–Nb are reviewed. The results obtained with U–Pu–Ti and U–Pu–Zr alloys containing 15 to 20% Pu and 10 wt % ternary element are reported. The transformation temperatures, the expansion coefficients, the nature of phases, and the thermal cycling behavior have been determined. A list of the principal properties of these different alloys is presented and the possibilities of their use as fast reactor fuel elements are considered. The U–Pu–Ti alloys seem to be quite promising: easiness of fabrication, large thermal stability, excellent behavior in air, small quantity of zeta phase, and temperature of solidus above 1100°C. (auth)

4648 (CONF-615-5) VACANCIES AND VACANCY COMPLEXES IN QUENCHED FCC METALS. D. Kuhlmann-Wilsdorf (Virginia. Univ., Charlottesville. School of Engineering and Applied Science). [1964]. Contract AT(40-1)-3108. 58p. Dep.(mn); $3.00(cy), 2(mn) OTS.

From International Conference on Lattice Defects in Quenched Metals, Argonne, Ill., June 1964.

A review is presented of work on quenched vacancies in metals. The various forms of vacancy aggregation are considered, and experimental methods for studying vacancies and their aggregates are discussed. The results of these methods are reviewed in detail. Evidence relating

to dislocations as sinks for vacancies, to vacancy aggregates caused by quenching, and to void formation is considered. Finally, the behavior of vacancies is discussed. (D.L.C.)

4649 (DMIC-205) THE EFFECTS OF HEAT-TREATING AND TESTING ENVIRONMENTS ON THE PROPERTIES OF REFRACTORY METALS. F. F. Schmidt, D. J. Maykuth, and H. R. Ogden (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 20, 1964. 23p. (AD-607481). $2.00 (OTS).

A review is presented on the information available on the effects of heat-treating and testing environments on the properties of the refractory metals and their alloys. The data for each of the four refractory metal alloy systems are separated into two categories according to whether exposures were in a vacuum or gaseous atmosphere. Several promising methods of circumventing material chemistry changes during various long-time, high-temperature exposures are discussed and evaluated. These include altering the environment by reducing pressure or increasing the purity of the nonreactive gaseous atmosphere; providing a contamination barrier in the work area; altering the sorption characteristics of the metal or neutralizing the environmental gases by combination with other intentionally added gases; and utilizing a low-density gas flush to reduce contaminant gases in the work area. It is pointed out that proper interpretation of the data is required in relating the type of atmosphere control needed to the specific application. The allowable contamination limits in heating and semi-finished products are not so critical as on finished mill products. Welding is another case where "finished" surfaces must be protected. Finally, long-time test or service requirements impose still another different set of conditions where the time-dependent variables become much more important than in the "process" treatments. (D.L.C.)

4650 (IS-867) MAGNETIC ANISOTROPY IN DYSPROSIUM SINGLE CRYSTALS. Terry Ting Jew and S. Legvold (Ames Lab., Ames, Iowa). Feb. 1963. Contract W-7405-eng-82. 49p. Dep.; $2.00(cy), 2(mn) OTS.

Two single crystals were grown by using the strain-anneal technique. Three rectangular parallelepiped samples were cut from these crystals with the long dimension directed along one of the hexagonal axes. These are designated as the $\langle 11\bar{2}0\rangle$ a-axis, the $\langle 10\bar{1}0\rangle$ b-axis, and the $\langle 0001\rangle$ c-axis. Magnetic measurements were made on the a-axis and the b-axis samples with the field up to 18 kilo-oersteds applied along the long dimension of the samples at temperatures from 4.2 to about 330°K. The a-axis was found to be the direction of easy magnetization while the c-axis is very hard magnetically. Magnetic anisotropy was observed in the magnetization curves below 110°K and above 110°K it gradually disappeared. In a plot of magnetic moment versus temperature a Néel temperature was observed at 178.3°K. This is to be compared with the value of 178.5°K reported by Behrendt et al. The saturation moment, $\sigma_{s,0}$, obtained by an extrapolation of the data was 355.1 ± 2 cgs units/gm by a T^2 plot. This is to be compared with the theoretical value of 343.8 cgs units/gm. The value of the Curie constant, C_g, is obtained from the slope of the (1/X) versus temperature plot. This gives a value of 10.83 Bohr magneton for the μ_{eff}. The theoretical value of μ_{eff} is given by the equation $\mu_{eff} = g[J(J+1)]^{\frac{1}{2}}$. The ground state of dysprosium is $^6H_{15/2}$ resulting in values of g = 4/3 and J = 15/2. One obtains μ_{eff} = 10.65 Bohr magneton. Electric resistivity measurements were made on the b-axis and c-axis samples. Both the c-axis and b-axis resistivity curves exhibit an abrupt change in slope at 88.4°K, which indicates the ferromagnetic-antiferromagnetic transition temperature. A Néel temperature of 179.6 ± 1°K was found from the change of slope of the b-axis resistivity curve. Above the Néel point the plots of resistivity versus temperature are essentially linear. It is to be noticed that the really significant resistivity anisotropy takes place in the paramagnetic region and near the Néel point. (auth)

4651 (MCW-1484(p.9-13)) EQUILIBRIUM PHASE COMPOSITIONS OF THE TERNARY ALLOY U–Si–Fe BY ELECTRON MICROPROBE ANALYSIS. L. A. Fergason, D. L. Parker, and N. F. Neumann (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

Isothermal sections of U–Si–Fe alloys at 1000, 1200, and 1350°F were investigated with an electron microprobe. Alloys representing the two-phase fields U + U_6Fe[Si] and U + U_6Fe[Si] + U_3Si were employed, and the tie line separating these fields was determined by measuring the solubility of Si in U_6Fe. The solubility of Si in U_6Fe was 3.8 and 2.9 at. % in the high alpha range and the high beta range, respectively. The presence of C at 544 ppM does not have a gross effect on this equilibrium. The solubility of Fe in the U_3Si phase was below the limit of detection by the microprobe (about 500 ppM). (auth)

4652 (MCW-1484(p.15-31)) ELECTRICAL RESISTIVITY AS A FUNCTION OF PREFERRED ORIENTATION— A SCOPING STUDY. K. R. Riggs (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

The manner in which the electric resistivity of normal alloy (150 ppM Fe, 100 ppM Si) beta-heat-treated U varies with the degree of quench-induced preferred orientation present as a result of a variety of quench rates from the beta phase was investigated. Results calculated from voltage-current measurements were compared with electric resistivities calculated from data taken by x-ray-diffraction techniques. The data relating measured electric resistivity and quench rate were inconclusive. From the standpoint of time and effort involved in each method, it was concluded that for specimen geometries of the type investigated, x-ray-diffraction techniques are more adequate in determining the degree of quench-induced preferred orientation than are measurements of electric resistivity. (auth)

4653 (NMI-7097-1(Del.)) EFFECT OF HEAT TREATMENT ON THE PROPERTIES OF HIGH-URANIUM ALLOYS CONTAINING ADDITIONS OF IRON, SILICON AND ALUMINUM. R. W. Anderson (Nuclear Metals. Div. of Textron Inc., West Concord, Mass.). July 28, 1964. Contract AT(30-1)-1565. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Response to heat treatment was observed in the microstructures and the hot hardness behavior of four high-uranium alloys containing different combinations of iron, silicon, and aluminum. The particle size distributions determined by electron microscopy showed that both solid solution and dispersion hardening could occur in these alloys to extents depending on the composition. (auth)

4654 (ORNL-3605(Vol.1)(p.3-25)) THE DETERMINATION OF THE LATENT HEAT OF VAPORIZATION, VAPOR PRESSURE, ENTHALPY AND DENSITY OF LIQUID RUBIDIUM AND CESIUM UP TO 1800°F. P. Y. Achener (Aerojet-General Nucleonics, San Ramon, Calif.). (AGN-TP-71)

Apparatuses for the measurement of latent heats of vaporization, vapor pressures, enthalpies, and densities of rubidium and cesium have been designed and operated. Experimental determination of these properties were obtained. The latent heats of vaporization of rubidium and cesium were measured from 970 to 1805°F and 1002 to 1596°F, respectively, in a system in which the saturation temperature was controlled by the pressure of the argon cover gas. The following equations were obtained for the latent heats of vaporization: h_{fg} (Btu/lb) = 414.8 – 0.0513T for rubidium and 257.4 – 0.0362T for cesium, where T = °F. In the same apparatus the vapor pressures were also measured. The following equations were obtained: $\log_{10}P$ (psia) = 5.20071 – (6994.68/T + 459.7) for rubidium and 5.09475 – (6680.185/T + 459.7) for cesium. These equations give values of the normal boiling point of 1274.4°F and 1241.1°F for rubidium and cesium, respectively. The enthalpies of rubidium and cesium were measured in a Bunsen ice calorimeter in the temperature range of 150 to 1650°F. The data obtained fit the following equations: $H^0_T - H^0_{32°F}$ (Btu/lb) = 9.012 + 0.09915T – 1.553 × 10^{-5} T^2 + 4.329 × 10^{-9} T^3 for rubidium and 2.711 + 0.08543T – 4.803 × 10^{-5} T^2 + 1.995 × 10^{-8} T^3 for cesium. From these equations the specific heats were obtained: C_p (Btu/lb-°F) = 0.09915 –

3.106×10^{-5} T + 1.299×10^{-8} T^2 for rubidium and 0.08543 – 9.605×10^{-5} T + 5.985×10^{-8} T^2 for cesium. The density of liquid rubidium and cesium was measured by the pycnometer method. The following equations were obtained for the density of rubidium and cesium: $d(g/cm^3) = 1.472/[1 + 1.3309 \times 10^{-4} (T-102) + 5.2106 \times 10^{-8} (T-102)^2]$ for rubidium and $1.84/[1 + 1.1755 \times 10^{-4} (T-82.4) + 7.656 \times 10^{-8} (T-82.4)^2]$ for cesium. (auth)

4655 (ORNL-3605(Vol.1)(p.66-87)) THERMOPHYSICAL PROPERTY MEASUREMENTS OF ALKALI LIQUID METALS. J. W. Cooke (Oak Ridge National Lab., Tenn.).

The final results of the experimental determination of the thermal conductivity of 99.8+ wt % molten lithium from 320 to 830°C are reported. The preliminary results obtained for the surface tension of 99.97 wt % molten potassium from 70 to 713°C using a maximum bubble-pressure apparatus are also given. (auth)

4656 (ORNL-3605(Vol.1)(p.116-38)) THERMOELECTRIC POTENTIALS OF MOLTEN AND REFRACTORY METALS. I. SEEBECK POTENTIALS OF SODIUM, POTASSIUM, RUBIDIUM, CESIUM, AND MERCURY VS. PLATINUM AND OTHER METALS. Charles F. Bonilla, Roland R. Kyi, Howard T. Drue, and Do-Ik Lee (Columbia Univ., New York).

Some applications of liquid-metal thermoelectricity are pointed out. Thermoelectric potential measurements with 0°C cold junctions are reported for solid metals (Ni, stainless steel, Haynes 25, Fe, and Mo) vs Pt, for Hg vs Fe, and for alkali metals (Na, K, Cs, and Rb) vs Pt. (D.L.C.)

4657 (ORNL-3605(Vol.2)(p.110-31)) POTASSIUM–MERCURY AMALGAM BOILING HEAT TRANSFER, TWO-PHASE FLOW, AND PROPERTIES INVESTIGATION. Y. S. Tang, C. R. Smith, and P. T. Ross (General Motors Corp. Allison Div., Indianapolis).

Boiling heat transfer (net and surface) and two-phase flow (void-velocity relations) results are reported for 44.5 and 14.7% potassium amalgams. The liquid-vapor phase equilibrium diagram of K–Hg was determined and compared with analytical data. (D.L.C.)

4658 (ORNL-3710) THERMAL DIFFUSION OF ANTIMONY AND RUTHENIUM IN SILVER. W. Biermann, D. Heitkamp, and T. S. Lundy (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 62p. Dep.; $3.00(cy), 2(mn) OTS.

The redistribution of antimony and ruthenium in very dilute solid solutions in silver under a temperature gradient was investigated by using radioactive tracer techniques. The experiments showed that the concentration of antimony increased at the hot side of the specimens and decreased at the cold side. The steady-state concentration was given by a straight line in a plot of logarithm of the antimony concentration versus the reciprocal absolute temperature. The redistribution could be described by an unusually large negative heat of transport, $Q^* = (-29 \pm 3)$ kcal/mole. The concentration profile for ruthenium in silver annealed under a temperature gradient was quite different from any redistribution which could be explained by thermal diffusion alone. No heat of transport could be calculated from the determined ruthenium concentration; the profile suggests only a negative value for the heat of transport for pure silver. Based on the thermodynamics of irreversible processes, an analysis is made of thermal diffusion in a dilute alloy. Expressions are derived which connect the experimental heat of transport Q^* with heats of transport for the movement of solvent and solute relative to the lattice planes. The existing kinetic theories are discussed and their parameters compared with the experimental results. The data cannot be described by the simple kinetic theory but can be explained by the kinetic treatment due to Wirtz if one assumes that the largest part of the activation energy for migration of the antimony atoms is required at the final site of the jumping atom. (auth)

4659 (TRG-Report-837) THE VOLATILITY OF PLUTONIUM AND PLUTONIUM OXIDES. A REVIEW OF EXPERIMENTAL METHODS AND RESULTS WITH A COMPLETE BIBLIOGRAPHY. J. Saxon, comp. (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). July 29, 1964. 10p. Dep.; $0.30(BIS), 1s. 9d. (HMSO).

A review of the experiments carried out in various laboratories to determine the vapor pressure of Pu and its oxides is presented. A bibliography complementary to the list of references is included. The sources of information are Nuclear Science Abstracts up to Vol. 18, No. 11, 15 June, 1964, with cross checks to Chemical Abstracts. (auth)

4660 (UCRL-11583) THE MOTION OF DISLOCATIONS IN COPPER SINGLE CRYSTALS (thesis). Pierre Petroff (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Coll. of Engineering). Sept. 1964. Contract W-7405-eng-48. 28p. Dep. (mn); $2.00(cy), 1(mn) OTS.

The motion of two types of dislocation configurations, namely grown in dislocations and punched prismatic loops were studied in copper. Copper single crystals of 10^5 dislocations per cm^2 were deformed in a cantilever bending test. Grown-in dislocations started to move at an average resolved shear stress of 2 g/mm^2. Their multiplication occurred at a stress of 15 g/mm^2 and slip lines appeared at a stress of 38 g/mm^2. Punched prismatic loops formed by dropping alumina particles on a single crystal have a much smaller mobility. The critical shear stress to move such a loop at room temperature was found to be 200 g/mm^2. The high stress needed to move prismatic loops is probably associated with a high density of jogs on the dislocations. (auth)

4661 (WADD-TR-60-646(Pt.IV)) REFRACTORY MATERIALS RESEARCH. G. M. Kibler, T. F. Lyon, M. J. Linevsky, and V. J. DeSantis (General Electric Co. Flight Propulsion Lab Dept., Evendale, Ohio). Oct. 1963. Contract AF33(616)-6841. 150p. (AD-606836). $5.00 (OTS).

Vapor pressure studies of Hf and Ta nitrides were completed using a Knudsen effusion method combined with a gas collection and measuring system. The vaporization of ZrB_2 was studied, also by a Knudsen effusion method, modified in this application to obtain the effusion rate by continuous weighing of condensed effusate. Matrix isolation studies of the vapor from ZrO_2 and HfO_2 were made as were additional measurements with ThO_2 which was a subject of an earlier investigation. Resonance line absorption photometry was applied to ZrB_2. Normal spectra emissivity data on single-crystal W, pyrolytic graphite, and Ta nitride are reported. (auth)

4662 (LA-tr-64-31) STUDY OF ALLOYS OF THE RHENIUM–CARBON SYSTEM. A. I. Evstyukhin (Evstiukhin), Iu. G. Godin, S. A. Kokhtev, and I. I. Suchkov. Translated by Helen J. Chick and Charles P. Kempter (Los Alamos Scientific Lab., N. Mex.), from Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot, No. 4, 149-59(1963). 16p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

An investigation was conducted of C–Re systems containing up to 37.1 at. % C, using melting, x-ray, and micro- and macro-hardness measurements. From the partial composition diagram thus constructed, a eutectic is found at 2500°C and 17 at. % C. The data indicate the existence of rhenium carbide. (D.L.C.)

4663 (UCRL-Trans-1087(L)) DETERMINATION OF PARAMETERS OF STATE OF SOLID BODIES AT HIGH PRESSURES BY THE METHOD OF PISTON DISPLACEMENT. Yu. S. Genshaft, L. D. Livshits, and Yu. N. Ryabinin. Translated by Sergey Shewchuck (Univ. of California, Lawrence Radiation Lab., Livermore), from Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 5, 107-16(1962). 26p. Dep. (mn); $2.00(cy), 1(mn) OTS; $2.66(fs), $0.98(mf) JCL.

The method of calculating the compressibility of solid bodies in the temperature range from 20 to 150°C and at pressures up to 30,000 kg/cm^2 is described according to the experimental data obtained by the piston displacement method. The data on compressibility are given for lead, silver chloride, cesium chloride, pyrophyllite, lithographic rock, graphite, boron nitride, bismuth and thallium for specified ranges of temperatures and pressures. On the

basis of these data we have shown the effect of the pressure on the temperature coefficient of volumetric expansion for six materials. To measure the compressibility of solid bodies and to determine the phase transitions in the volume "jumps" which are connected with them, the "piston displacement" method was successfully used. Since the literature ordinarily gives references to this method without describing them in sufficient detail, the general scheme for treatment of the measurement results is presented along with the p-V-T. (auth)

4664 (UCRL-Trans-1130) ON THE FORMATION AT HIGH TEMPERATURE OF PHASE-TYPE ALUMINA IN DIFFERENT SYSTEMS OF OXIDES WITH AN ALUMINA BASE AND IN THE SYSTEM ALUMINA–ALUMINUM NITRIDE. (Anne-Marie Lejus and Robert Collongues (France. Centre National de la Recherche Scientifique. Laboratoire de Vitry). Translated by D. A. Nimidoff (Univ. of California Lawrence Radiation Lab., Berkeley), from paper Presented at "5th International Symposium on the Reactivity of Solids, Munich, Aug. 1964." 13p. Dep;(mn); $1.60(fs), $0.80(mf) JCL.

In mixtures of Al_2O_3 with other metallic oxides, spinels are formed which have a tendency to dissolve more Al_2O_3 at high temperatures. At the limits of the homogeneity domains, a spinel of the phase type δ–Al_2O_3 appears. The phase succession $\gamma \rightarrow \delta \rightarrow \alpha$ was studied in mixtures of Al_2O_3 with MgO, NiO, Li_2O, and AlN. The phase stabilization in Al_2O_3 at high temperatures is discussed. (D.L.C.)

4665 THE CRYSTAL STRUCTURE OF PHASE C IN THE TERNARY SYSTEM CERIUM–PLUTONIUM–COBALT. Allen C. Larson, R. B. Roof, Jr., and Don T. Cromer (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 17: 1382-6 (Nov. 10, 1964). (LADC-6081)

Phase C in the ternary cerium–plutonium–cobalt system has the approximate formula $(Pu,Ce)_5Co_3$. The phase is tetragonal, space group I4/mcm, with a = 10.730 and c = 5.383 Å and is isostructural with W_5Si_3. A structure is proposed having vacancies, substitutional disorder, and positional disorder. (auth)

4666 COMPOUNDS OF YTTRIUM, SAMARIUM, AND GADOLINIUM WITH MERCURY. Hans Rudolf Kirchmayr (Technische Hochschule, Vienna). Acta Phys. Austriaca, 18: 193-204(1964). (In German)

The preparation of compounds of rare earths and mercury by direct reaction between the rare earth and mercury in the temperature range from 200 to 500°C was reported. The compounds SEHg, $SEHg_2$, and $SEHg_3$ (SE = Y, Sm, and Gd) were prepared; and their structures were determined. The lattice dimensions of the Sm compounds agree with previously determined values and those of YHg, YHg_2, YHg_3, GdHg, $GdHg_2$, and $GdHg_3$— compounds prepared for the first time— correspond to the theoretically expected values calculated from the change in atomic radius with the atomic number. (tr-auth)

4667 IMPORTANCE OF ROENTGENOGRAPHIC LATTICE EXPANSION MEASUREMENTS FOR METAL PHYSICS AND METALLURGY. E. Macherauch (Max-Planck-Institut für Metallforschung, Stuttgart). Acta Phys. Austriaca, 18: 364-407(1964). (In German)

A review is presented of the use of roentgenographic measurements in the determination of lattice expansions. Reflection methods for lattice measurements on single crystals, single crystallites, and multicrystals and goniometer methods for measurements of interference line profiles at any Bragg angle are summarized. 108 references. (J.S.R.)

4668 VISCOSITY-COMPOSITION RELATIONSHIPS IN MOLTEN PLUTONIUM–IRON ALLOYS. Donald Ofte and L. J. Wittenberg (Mound Lab., Miamisburg, Ohio). Am. Soc. Metals, Trans. Quart., 57: 916-24(1964). (MLM-1224J)

The viscosities of plutonium alloyed with 0, 1, 5, 9.5, and 13 at. % iron were measured in an oscillating cup viscosimeter. The function of viscosity of each of the alloys decreased linearly with increasing temperature when viscosity was plotted as log (η/T) as a function of reciprocal absolute temperature (1/T), as expected for simple liquids. Self-diffusion in molten plutonium metal was calculated from the viscosity data. Liquidus temperatures of the alloys were measured within ±2°C. A plot of viscosity as a function of alloy composition at selected temperature intervals above the liquidus temperatures revealed a pronounced increase in viscosity of the liquid with increasing iron content up to the 9.5 at. % iron eutectic composition. Viscosities at liquidus temperatures for the 0, 1, 5, 9.5, and 13 at. % iron alloys were 6.0 centipoise at 640°C, 6.5 centipoise at 628°C, 11.8 centipoise at 549°C, 25.2 centipoise at 411°C, and 17.8 centipoise at 460°C, respectively. (auth)

4669 CLEAVAGE IN HYDRIDED ZIRCALOY-2. M. R. Louthan, Jr. (E. I. du Pont de Nemours & Co., Aiken, S. C.). Am. Soc. Metals, Trans. Quart., 57: 1004-8(1964).

The effects of hydride precipitates as the mode of fracture of Zircaloy-2 were investigated. Metallographic examination of polished sections of ductile specimens showed that the hydride orientation in the specimen before testing was approximately random and that during deformation the hydrides rotated so that they were parallel to the major direction of deformation. Fracture occurred by the coalescence of voids. The center of the specimen fractured by ductile rupture, while the fracture near the edges occurred by ductile shear. Hydride orientation in brittle specimens was normal to the stress axis and did not change during fracture because only limited deformation occurred. Fracture occurred by discontinuous cleavage. (M.C.G.)

4670 STAINLESS STEELS IN REACTOR TECHNOLOGY. H. Jesper and G. Grutzner (Stahlwerke Sudwestfalen AG, Geisweid, Ger.). Atomwirtschaft, 9: 161-7 (Apr. 1964). (In German)

The properties that make stainless steels suitable for use in reactor construction are reviewed. The corrosion behavior of stainless steels, and their behavior under irradiation are stressed. (D.C.W.)

4671 THERMOELECTRIC PROPERTIES OF U_3X_4 AND SOME HIGHER URANIUM COMPOUNDS. I. H. Warren and C. E. Price (Univ. of British Columbia, Vancouver). Can. Met. Quart., 3: 245-56(July-Sept. 1964).

Room temperature thermoelectric and x-ray data are reported for U_3P_4, U_3As_4, U_3Sb_4, U_3Se_4, and U_3Te_4. For U_3As_4 the temperature variations of thermoelectric power and electric conductivity up to 900°C are shown, and attempts at modification of properties are described. Some thermoelectric data are presented for USb_2, UOS, UOSe, UOTe, US_2, U_2S_5, UAl_3, USi_3, USn_3, and UPb_3. Only the oxy-compounds appear to be of practical interest. (auth)

4672 RECOVERY AND SEGREGATION OF URANIUM IN STEEL. R. K. Buhr and D. R. Bell. Can. Mining Met. Bull., 57: 525-9(May 1964).

Methods for the addition of uranium to steels and cast iron were investigated. Unsegregated areas were found to be extremely low in total oxygen, acid insoluble aluminum (Al_2O_3), and, in some cases, slightly lower in nitrogen. Uranium recoveries, based on analyses of the unsegregated areas, were quite constant, at about 45%, regardless of the type of uranium master alloy used for the addition. No segregation of carbon, manganese, silicon, sulfur, phosphorus, chromium, or copper was observed in these steels. (TCO)

4673 DEVELOPMENT OF SPECIAL GRAPHITES FOR GAS-COOLED GRAPHITE-MODERATED REACTORS. F. Roberts (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Chem.-Ingr.-Tech., 36: 849-57(Aug. 1964). (In German). (AERE-R-4416)

The development of special graphites for gas-cooled, graphite-moderated reactors at the Harwell experimental graphite plant is described. The continuing importance of graphite as a material for incorporation in reactors is emphasized. A detailed description is given of how the structure and properties of graphite can be promoted in a given direction during the production process. The fillers, binding agents, pressure, and temperature are of par-

ticular significance in the combustion process, as also is the impregnation. Empirical relationships are given for estimating the material characteristics of a specific graphite. (auth)

4674 FORCE CONSTANTS OF THE GRAPHITE LATTICE FROM SPECIFIC HEAT DATA. Tun-chien Lee and Jenn-Lin Hwang. Chinese J. Phys. (Taiwan), 2: 85-7(Oct. 1963).

Lattice constants for graphite were determined from the values for specific heat and the Debye parameter by means of the Krumhansl-Brooks theory. Consideration was given to the vibrational modes as influenced by temperature. (Rev. Metal Lit., 21: No. 11, Nov. 1964).

4675 COMPARATIVE STUDY OF THE FLOW OF POLYCRYSTALLINE URANIUM AND ITS ALLOYS WITH MOLYBDENUM AT 0.5 AND 1.1% BETWEEN 415 AND 630°C. Pierre Grenier (Ecole des Mines, Paris). Compt. Rend., 259: 1956-9(Sept. 21, 1964). (In French)

Study of variations of the deformation velocity as a function of temperature makes possible the determination of activation energies for the flow of polycrystalline uranium and its alloys with 0.5 and 1.1% Mo. Above 520°C the values of the activation energy of the different plateaus obtained depend linearly on the molybdenum concentration and show that the deformation mechanism of the metal is unique and controlled by a diffusion process. (tr-auth)

4676 HEXAGONAL LAVES PHASES IN ALLOYS OF MAGNESIUM WITH RARE EARTH METALS. P. I. Krpyakevich, V. I. Evdokimenko, and I. I. Zalutskii. Dopovidi Akad. Nauk Ukr. RSR., No. 6, 766-9(1964). (In Ukrainian)

Compounds of $EuMg_2$, $TbMg_2$, $ErMg_2$, $YbMg_2$, and YMg_2 were prepared by melting the high-purity components in a crucible using a NaCl–KCl flux. X-ray investigation of the parameters and dimensions of these compounds and a comparison to the Laves' phase structure of $MgCu_2$, $MgZn_2$, or $MgNi_2$ was made. (Rev. Metal Lit., 21: No. 11, Nov. 1964).

4677 CRYSTAL STRUCTURE OF COMPOUNDS RPb_3 IN SYSTEMS RARE-EARTH METAL–LEAD. Y. B. Kuzma, R. V. Skolozdra, and V. Ya. Markiv. Dopovidi Akad. Nauk Ukr. RSR, No. 8, 1070-2(1964). (In Ukrainian)

By means of x-ray diffraction the structure of the compounds RPb_3 (R = Y, Eu, Tb, Dy, Ho, Er, Tm, and Yb) was found to be the $AuCu_3$ type. The RPb_3 compounds exist in equilibrium with Pb. No analogous compound was found in the system Lu–Pb. Data on lattice constants are tabulated. (auth)

4678 THERMAL EXPANSION OF TUNGSTEN, MOLYBDENUM, TANTALUM, NIOBIUM, AND ZIRCONIUM AT HIGH TEMPERATURES. V. M. Amonenko, P. N. V'yugov, and V. S. Gumenyuk (Inst. of Physics, Academy of Sciences, Ukrainian SSR). High Temp., 2: 22-4(Jan.-Feb. 1964). Translated from Teplofiz. Vysokikh Temp., 2: 29-31(Jan.-Feb. 1964).

A study was made of the thermal expansion of W, Mo, Ta, Nb, and Zr at temperatures up to 2000°C (zirconium only to 1450°C) in a vacuum contact dilatometer. Empirical expressions are given for the elongation and true coefficients of linear expansion as functions of temperature for all the metals. The results on the expansion for tantalum, molybdenum, and tungsten agree with published values; those for niobium are slightly larger, which can probably be ascribed to impurities in the niobium. (auth)

4679 EFFECTS OF METAL DEFECTS ON POSITIVE ION EMISSION FROM HEATED IRON FILAMENTS. R. F. Tinder, G. A. Antypas, and E. E. Donaldson (Washington State Univ., Pullman). J. Appl. Phys., 35: 3452-5(Dec. 1964).

The positive ion current emitted by heated filaments of high-purity Fe displayed sharp maxima when the metal passed through the structural transformation temperature. The height of the maxima varied with previous flashing temperatures and with the direction of approach to the transformation. Plastic deformation also produced maxima in the positive ion current after a temperature-dependent time delay; the peak height was approximately proportional to strain. Electron emission from the same filaments was unaffected by these factors. The results suggest that the positive ion emission from flash-cleaned Fe filaments is not surface controlled and they seem to require internal rate controlling mechanisms that involve diffusion of the impurity species to the surface along high diffusivity paths. (auth)

4680 CRYSTAL ANISOTROPY IN GRAPHITE AND URANIUM. R. V. Hesketh (Berkeley Nuclear Labs., Gloucestershire, Eng.). J. Appl. Phys., 35: 3604-6(Dec. 1964).

A parallel is drawn between polycrystalline graphite and uranium. The elastic, thermal cycling, and irradiation creep strains are all dependent on crystal anisotropy. Nonlinearity of the stress–strain curves is shown to be a property of geometry rather than of the materials. The thermal cycling and irradiation creep strains have their expected values in uranium, but are ten times less in graphite. It is suggested that in graphite the appropriate unit of growth is not the single crystal but a small group of crystals bounded by Mrozowski cracks. (auth)

4681 HIGH-TEMPERATURE HEAT CONTENT OF NIOBIUM. Donald T. Hawkins and Raymond L. Orr (Univ. of California, Berkeley). J. Chem. Eng. Data, 9: 505-7(Oct. 1964). (UCRL-11190)

High-temperature heat contents of niobium were measured over the temperature range 298 to 1415°K, using a diphenyl ether calorimeter. Smoothed values of the thermal properties of niobium, $H^0_T - H^0_{298}$, C_p, $S^0_T - S^0_{298}$, and $(F^0_T - H^0_{298})/T$, were derived and tabulated at even 100°K intervals. Within an average deviation of 0.10%, the tabular heat content values are given by the expression: $H^0_T - H^0_{298.15} = 5.885T + 4.044 \times 10^{-4}T^2 + 2.194 \times 10^4T^{-1} - 1864$. (auth)

4682 MAGNETIC PROPERTIES OF Gd–Sc ALLOYS. H. E. Nigh, S. Legvold, F. H. Spedding, and B. J. Beaudry (Ames Lab., Ames, Iowa). J. Chem. Phys., 41: 3799-3801 (Dec. 15, 1964). (IS-949)

Magnetic properties of some Gd–Sc alloys were measured. Paramagnetic to antiferromagnetic to ferromagnetic transitions were observed in the 69 at.% Gd alloy. Alloys of higher Gd content were ferromagnets and those of lower Gd content were antiferromagnets. The paramagnetic Curie temperatures decreased with decreasing Gd concentration. The effective number of Bohr magnetons per Gd atom showed a nearly linear increase with decreasing Gd concentration. Also the saturation magnetic moment per Gd atom increased with decreasing Gd concentration in the case of the ferromagnets. (auth)

4683 MÖSSBAUER EFFECT MEASUREMENTS OF HYPERFINE INTERACTIONS IN LAVES PHASES CONTAINING Fe COMBINED WITH Ti, Zr, Y, AND THE LANTHANIDE METALS. W. E. Wallace (Westinghouse Electric Corp., Pittsburgh and Univ. of Pittsburgh). J. Chem. Phys., 41: 3857-63(Dec. 15, 1964).

^{57}Fe Mössbauer absorption spectra were obtained for the Laves-phase compounds AFe_2 in which A = Ti, Zr, Y, Ce, Sm, Gd, Tb, Dy, Ho, Er, Tm, and Lu. $TiFe_2$ and $CeFe_2$ are paramagnets at room temperature and hence only show quadrupole interactions (0.21 and 0.40 mm/sec, respectively). The others exhibit a magnetic hyperfine interaction at room temperature and all show this at the liquid-nitrogen point. The pattern obtained for $TiFe_2$ at 78°K is complex and has been interpreted as indicating two types of Fe, one of which is magnetically ordered and for which the hyperfine field is 71 kOe, whereas the other type is either not magnetically aligned, or if it is, the field is less than 10 kOe. Fe moments for the other compounds were obtained either directly from experiment or estimated from the experimental results using Bleaney's exchange induction effect. These moments were compared with the measured hyperfine fields. Due to the limited range of variability of the moments and fields their functional interrelationship cannot be unambiguously established. A linear relationship seems to be indicated. This is interpreted to imply that only conduction and core electron polarizations contribute significantly to the hyperfine field in the (cubic) AFe_2 com-

pounds, and the latter varies linearly with the localized Fe moment. (auth)

4684 THE HEAT TREATMENT AND MECHANICAL PROPERTIES OF Mg–Th–Zr ALLOY. Takuichi Morinaga, Tsuneo Takahashi, Hisao Konno, and Yoshio Sawada. Light Metals, 14: 51-5(May 1964). (In Japanese)

The effects of heat treatment in the temperature range from 205 to 565°C on tensile properties, hardness, and yield strength of a Mg–Th–Zr alloy were studied. The influence of composition on properties was considered. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4685 THE AGING PHENOMENA OF A Mg–3% Th–0.7% Zr ALLOY. Takuichi Morinaga, Tsuneo Takahashi, and Hisao Konno. Light Metals, 14: 56-9(May 1964). (In Japanese)

The mechanism of age hardening in a Mg–3% Th–0.7% Zr alloy was investigated by measuring hardness, thermal expansion, and electrical resistance. X-ray-diffraction and microscopic observations were used. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4686 ALUMINUM AND MAGNESIUM IN REACTORS. PART I. L. M. Wyatt. Metal Ind. (London), 104: 252-5 (Feb. 20, 1964).

Determining factors in the choice of Al for graphite-moderated natural uranium or water-cooled reactors are discussed. Techniques used in cladding and rolling Al–U alloy cores with Al sheet and in canning U in extruded Al alloy containers are described. The performance of Al under irradiating conditions and at temperatures at which Al and U interdiffuse are reported. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4687 THE THERMAL AND ELECTRICAL CONDUCTIVITY OF MAGNESIUM AND SOME MAGNESIUM ALLOYS. R. W. Powell, M. J. Hickman, and R. P. Tye (National Physical Lab., Teddington, Middx., Eng.). Metallurgia, 70: 159-63(Oct. 1964).

Results are presented and discussed for the thermal conductivity, λ, and electric resistivity, ρ, of two samples of magnesium and twenty-eight magnesium alloys. The measurements were made over a number of years and cover various temperature ranges between room temperature and 773°K. A least-squares analysis leads to the equation $\lambda = 2.206 \times 10^{-8}\, T\rho^{-1} + 0.096$, where λ is expressed in watt cm^{-1} deg C^{-1}, ρ in ohm cm, and T in °K. The majority of the measured values agree to within 3% and the remainder to within 6% of this line. The equation $\lambda = 2.20 \times 10^{-8}\, T\rho^{-1} + 0.10$ should serve to estimate thermal conductivities from measured electric resistivities to within about 5% for magnesium and its alloys and for aluminum alloys, except those having appreciable silicon contents. (auth)

4688 THE TERNARY SYSTEMS MOLYBDENUM–ALUMINUM–CARBON AND TUNGSTEN–ALUMINUM–CARBON. W. Jeitschko, H. Nowotny, and F. Benesovsky. Monatsh. Chem., 95: 30-8(1964). (In German)

Phase equilibria in Mo–Al–C specimens sintered from 650 to 1800°C were investigated by microscopy, x-ray diffraction, and melting tests. Representations of the established phase diagrams in terms of projections into the concentration triangle are given. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4689 UTILIZATION OF BeO IN HIGH TEMPERATURE GAS COOLED REACTOR. Susumu Nishigaki. Nippon Genshiryoku Gakkaishi, 6: 583-92(Oct. 1964). (In Japanese).

A summary of information presented at the international conference on BeO as nuclear material is presented. BeO possesses outstandingly attractive nuclear and high-temperature properties as fuel matrix material. Therefore, BeO is planned to be used in the Australian High Temperature Gas Cooled Reactor Project (HTGCR) and the General Atomic's High Temperature Gas Cooled Reactor system (HTGR) in the U. S. A. The use of BeO in reactors has several excellent merits. High gas outlet temperature is realized. BeO has a low capture cross section and offers the additional advantage of neutron reproduction from the (n,2n) reaction. A dispersion-type fuel permits high power density and high fissile material heat rating. BeO also shows satisfying properties in fission product release. (P.C.H.)

4690 OCCURRENCE OF DUCTILE HYDRIDES IN ZIRCALOY-2. G. W. Parry and W. Evans (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucleonics, 22: No. 11, 65(Nov. 1964).

Previous work showed that in Zircaloy containing zirconium hydrides oriented normal to an applied tensile stress the room-temperature ultimate tensile strength and ductility were drastically reduced. Tests have also shown that below 600°C solid zirconium hydride has little or no ductility over a wide range of composition. Experimental results are presented that demonstrate that the tensile properties of hydrided Zircaloy are restored in the range 100–200°C due to plasticity of the hydrides. The mechanism is not clear, but the temperature increase may change the generally accepted composition $ZrH_{1.5}$ to a ductile form, or there may exist a complex relation between the hydride phase and the zirconium matrix. (C.E.S.)

4691 THE PAULI SUSCEPTIBILITY OF LIQUID AND SOLID LITHIUM. J. E. Enderby, J. M. Titman, and G. D. Wignall (Univ. of Sheffield, Eng.). Phil. Mag. (8), 10: 633-40(Oct. 1964).

Relative values for the Pauli susceptibility of solid and liquid lithium were obtained by using conduction electron spin resonance. A marginal oscillator operating at 16 Mc/s was used, and high signal to noise ratios were achieved. The ratio of the susceptibilities in the liquid and solid state was found to be 1.04 ± 0.05; this suggests, assuming that the role of electron-electron interactions is unchanged at the melting point, a rather small change in the density of states at the Fermi surface. (auth)

4692 GRAIN BOUNDARY TOPOGRAPHY IN TUNGSTEN. H. F. Ryan and J. Suiter (Commonwealth Scientific and Industrial Research Organization, Melbourne and Univ. of Melbourne). Phil. Mag. (8), 10: 727-9(Oct. 1964).

Grain boundaries were observed in tungsten using a field-ion microscope. The presence in grain boundaries of small protrusions similar to those postulated by Gifkins and McLean was confirmed. (D.C.W.)

4693 IDENTIFICATION OF PRISMATIC LOOPS IN ZONE-MELTED MOLYBDENUM. A. Lawley and J. D. Meakin (Franklin Inst., Philadelphia). Phil. Mag. (8), 10: 737-43(Nov. 1964).

Prismatic dislocation loops originating at precipitate particles in zone-melted molybdenum were shown to be interstitial in nature with an (a/2)⟨111⟩ Burgers vector. The mode of generation of the prismatic loops from a dislocation helix is apparent and is consistent with the mechanism proposed by Jones and Mitchell. (auth)

4694 NUCLEAR RESONANCE OF Co^{59} IN SOME COBALT-RICH ALLOYS. J. M. Brettell (Monash Univ., Clayton, Australia). Phys. Letters, 13: 100-1(Nov. 15, 1964).

The nuclear resonance of ^{59}Co was observed in Co alloys containing <1% of Eu, Gd, or Nd. The results exclude the possibility of dipolar line splitting by the magnetic moment of the impurity and indicate that the impurities produce equal perturbations on the host atoms. The effects of Cu, Fe, and Ni on the nuclear resonance of ^{59}Co were also studied. (D.C.W.)

4695 ION-ION OSCILLATORY POTENTIALS IN LIQUID METALS. M. D. Johnson (Univ. of Sheffield, Eng.), P. Hutchinson, and N. H. March. Proc. Roy. Soc. (London), Ser. A, 282: 283-302(Nov. 3, 1964).

Radial distribution functions obtained by x-ray and neutron measurements were analyzed for eight liquid metals, Li, Na, K, Rb, Cs, Hg, Al, and Pb, and for the liquid insulator Ar. It is shown that pair potentials between the ions in liquid metals can be obtained from the data, and that the general features of these curves are similar on the basis of various approximate theories of liquids. In particular,

the Born–Green theory and the method of Percus & Yevick were used in all cases. For the eight liquid metals, and for two different temperatures in each case, long-range oscillatory interactions are always found in the ion-ion potentials. While these general features of the pair potentials are the same in Born–Green and Percus–Yevick theories, in the important region round the first minimum and the following maximum the results are quantitatively different. The potentials, however, are only weakly temperature-dependent in the Born–Green approach, and the approximate validity of this method for liquid metals appears to receive further confirmation from calculations of viscosity and surface tension, which are in quite surprisingly good agreement with experiment. The Percus–Yevick approach seems distinctly less good for metals, but may perhaps be more appropriate to deal with liquid insulators. However, many body forces may also be important in argon. The long-range oscillations are interpreted as conduction electron screening of the ions, though the amplitude of the oscillations is substantially greater than a Hartree point-ion model predicts. It is pointed out that core sizes and/or electron interactions will have to be incorporated carefully into the screening theory in order to understand the present findings in a fully quantitative way. The long-range oscillations afford striking evidence that the Fermi surface is quite sharp even in a liquid metal like mercury, where the mean free path is short. Some evidence of the damping of the oscillations is found, and rough values thereby obtained for the blurring of the Fermi distribution. Sodium remains a somewhat puzzling case, as the oscillations appear to fall off rather more slowly than theory would predict. By means of the Ornstein–Zernike direct correlation function f, it is pointed out that, solely from radial distribution function data which appears at first sight rather similar for insulating and conducting liquids, the two types may be distinguished. For insulators, f has no nodes, whereas for metals it has marked oscillations. This suggests that f is closely connected with the pair interaction $\phi(r)$, and by analysis of the equations of the Born–Green, Percus–Yevick, and hyperchain methods, it is shown that they all yield $f(r) = -\phi(r)/kT$ for sufficiently large r. It is inferred therefore that this is a general result, and does not depend on the use of approximate theories. (auth)

4696 STRETCHER-STRAIN MARKINGS AND YIELD PHENOMENA IN AN Al–Li ALLOY. Shiro Terai and Yoshio Baba. Sumitomo Keikinzoku Giho, 4: No. 3, 11-17 (July 1963). (In Japanese)

A study was made on the yield phenomena and stretcher-strain markings in Al–3% Li alloy. The effects of Li content, annealing, aging, heat treatment, and hot and cold rolling were investigated. Mechanisms are postulated to explain the two types of yield phenomena observed. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4697 LATTICE DEFECTS IN QUENCHED AND DEFORMED URANIUM. K. Tangri and B. D. Sharma. Trans. Indian Inst. Metals, 16: 178-83(Sept. 1963).

Nature and configurational stability of lattice defects, such as point defects and dislocations, in uranium were determined. Using residual resistivity decay methods, activation energy for the migration of a lattice vacancy in quenched uranium was found to be 0.8 ev at room temperature. Experimental evidence was found for probable formation of vacancy aggregates in deformed uranium. (Rev. Metal Lit., 21: No. 11, Nov. 1964)

4698 USE OF RHENIUM AND RHENIUM ALLOYS FOR ELECTRON TUBES. J. W. Kotowski and K. M. Tischer (Telefunken AG, Ulm, Ger.). Vakuum-Tech., 13: 214-20 (Oct. 1964). (In German)

A comprehensive survey is given on the physical, chemical, and mechanical properties of rhenium and some alloys of rhenium with W, Mo, Ta, and Cr especially with respect to vacuum-tube-application. (auth)

4699 REFRACTORY METALS FOR HIGH-TEMPERATURE HEATING ELEMENTS. Edwin S. Bartlett. Wire Wire Prod., 39: 722-6; 765-7(May 1964).

High-temperature properties of Pt, Pt-10% Rh, Pt-40% Rh, Mo, Nb, W, and Ta were determined. Furnaces using Pt or Mo wire-wound alumina muffles were limited to temperatures below 3500°F by the softening point of the ceramic. Self-supporting furnaces using Mo helix wire or Nb, Ta, or W strip as heating elements operated at 3800 to 5100°F. Data are given on atmosphere requirements and effect of high temperatures on electric resistance of refractory metals. (Rev. Metal Lit., 21: No. 11, Nov. 1964).

4700 EFFECTIVE MAGNETIC FIELDS ON NUCLEI OF ANTIFERROMAGNETIC TRANSITION METALS. P. N. Stetsenko and Yu. I. Avksentev (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 806-11(Sept. 1964). (In Russian)

A method for measuring the specific heat at ultralow temperatures is developed, and the effective magnetic fields on manganese and chromium nuclei determined from the magnitude of the nuclear thermal capacity are investigated. Both metals exhibit significant hyperfine interaction. The effective field strength on manganese nuclei is 100 kOe and on chromium nuclei 150 kOe. (auth)

4701 SPLAVY NIOBIYA. (Niobium Alloys). D. A. Prokoshkin and E. V. Vasul'eva. Moscow, Izdatel'stvo "Nauka," 1964. 331p.

An analysis is made of the basic problems in Nb and Nb alloy metallography. A review is given of the chemical, physical, mechanical, nuclear, thermal, and technological properties of Nb. Constitution diagrams are included for binary, ternary, and more complex alloys and their structures and uses are considered. (R.V.J.)

4702 THE EFFECT OF BERYLLIUM CONCENTRATION ON PART STRENGTH AND MECHANICAL PROPERTIES OF "HIGH PURITY" 356-T6 VARIANT TYPE ALUMINUM ALLOYS. W. A. Bailey. 40p. (CONF-450-3)

From American Foundrymen's Society Meeting, Atlantic City, Apr.-May 1964.

An investigation was conducted to determine the effect of variations of beryllium content on the mechanical properties and part strengths of high purity 356-T6 type aluminum alloys. Results are reported that were obtained from a series of similar Tee-shaped test castings, poured by two foundries in both sand and permanent mold, using metal of six different compositions. The Tee's of all chemistries were solution heat treated similarly and were aged for various times at two temperatures. Both in sand castings and in chilled castings, at any aging temperature of time used experimentally, ultimate strength and yield strength increased from five to ten percent with a 0.20 wt % increase in beryllium concentration. Elongation was not affected by beryllium additions. Part strength as tested in bending, was increased by this increase in beryllium content approximately five % when aluminum chills were used, three % when iron chills were used, and ten % when unchilled. (auth)

4703 LOW TEMPERATURE SPECIFIC HEAT OF SOLID SOLUTIONS OF THE THIRD TRANSITION SERIES. E. Bucher F. Heiniger, and J. Muller (Swiss Federal Inst. of Tech., Zurich). 15p. (CONF-651-27)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The electronic specific heat of alloys belonging to the 5d transition series were measured and compared with corresponding data in the case of bcc 3d, 4d, and 5d alloys. In the bcc region of alloys with less than 6 electrons per atom, the electronic specific heat varies similarly in all three transition series. A comparison of the band shapes indicates a progressive broadening in the sequence of the 3d-, 4d-, and 5d- periods. A comparison of the electronic specific heats of alloys of the 6th column elements (Cr, Mo, W) with Re revealed an interesting anomaly exhibited by the Cr alloys. It was concluded that outside the range of magnetic anomalies, the behavior of the alloys considered supports the qualitative validity of the rigid band approximation in all transition metal series. (P.C.H.)

4704 IMPROVEMENTS IN OR RELATING TO URANIUM DIOXIDE. Walter Bauschmann and Roger Pascard (to Commissariat à l'Énergie Atomique). British Patent 970,735. Sept. 23, 1964. Priority date Dec. 30, 1960, France.

Preparation of a fuel of sintered UO_2 of high density is described. In an example, 0.4 wt % Nb_2O_5, 3 wt % camphor, and 0.5 wt % stearic acid are added to stoichiometric UO_2 of specific surface area 0.9 m^2/g. This is compressed at 4750 kg/cm^2 and heated at 200°C increase/hr to 350°C for 2 hours, then sintered at 1200°C for 4 hours. Pellets are obtained with density of 10.54 g/cc. (T.R.H.)

4705 IMPROVEMENTS IN OR RELATING TO MAGNESIUM BASE ALLOYS. Philip Andrew Fisher (to Magnesium Elektron Ltd.). British Patent 974,571. Nov. 4, 1964. Filed June 5, 1962.

A magnesium alloy for canning uranium fuel is described. It contains 0.8% Al, 0.01% Be, and 0.05 to 1% Si. The Si gives improved grain growth resistance at high temperatures. Mn, Ca, and Zn are also present. (T.R.H.)

4706 ZIRCONIUM ALLOYS. Stanley Kass, Wilber W. Kirk, and Donald W. Bright (to Westinghouse Electric Corp.). U. S. Patent 3,148,055. Sept. 8, 1964. Filed Apr. 14, 1960.

A zirconium alloy with corrosion resistance and mechanical strength is offered. It contains 1.3 to 1.6% Sn, 0.07 to 0.12% Cr, 0.04 to 0.08% Ni, 0.09 to 0.16% Fe, and 0.125% O_2. Nitrogen was below 50 ppm and carbon less than 0.05%. (T.R.H.)

4707 METHOD OF PREPARING RARE EARTH-ACTINIDE METAL OXIDE SOLS. Frederick T. Fitch and Jean G. Smith (to W. R. Grace and Co.). U. S. Patent 3,148,151. Sept. 8, 1964. Filed Feb. 27, 1962.

A process is described for preparing stable sols of UO_2 and rare-earth oxides for reactor fuel. In an example of the process, 69.6 g of reactive UO_2 sol (3 to 7 mμ particles, 3.9 g/100 ml) was mixed with 66.6 ml of Y_2O_3 sol (5 g/100 ml). The UO_2 sol was prepared by electrodialysis of UO_2Cl_2 solution. The Y_2O_3 sol was prepared by peptizing $Y(OH)_3$ washed with acetic acid at 60°C. The mixed sol was diluted to 600 ml and heated at 150°C for 23 hours in a stirred autoclave. The product was deionized and concentrated. Homogeneous particles averaging 65 mμ with 7 mμ sub-particles were obtained. (T.R.H.)

4708 ALLOYS. Douglas White, John Frederick George Conde, and Peter Charles Leslie Pfeil (to United Kingdom Atomic Energy Authority). U. S. Patent 3,148,978. Sept. 15, 1964. Priority date Feb. 2, 1960, Great Britain.

Austenitic stainless steel alloys were developed, which consists of less than 0.07 wt % C, 0.5 to 1 wt % Mn, 0.25 to 0.75 wt % Si, 24 to 26 wt % Ni, 19 to 21 wt % Cr, up to 0.75 wt % Nb, and the remainder iron and incidental impurities. These alloys showed good neutron economy, good corrosion resistance, good creep strength and ductility, freedom from inclusions, good fabrication properties, and fine grain size. (M.C.G.)

4709 MAGNESIUM BASE ALLOY CONTAINING SMALL AMOUNTS OF RARE EARTH METAL. George S. Foerster (to Dow Chemical Co.). U. S. Patent 3,157,496. Nov. 17, 1964. Filed Sept. 13, 1962.

An alloy with good high-temperature and creep properties is offered. The alloy contains at least 85 wt % Mg (Th-free) and 0.05 to 2 wt % rare earth metal, and 0.05 to 0.5 wt % Zn. (T.R.H.)

Radiation Effects

4710 (AAEC/E-130) EXAMINATION OF BeO IRRADIATED AT ELEVATED TEMPERATURES IN THE ENGINEERING TEST REACTOR. B. S. Hickman and J. Chute (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1964. 19p. Dep.(mn).

A description is given of an examination of BeO samples irradiated in the Engineering Test Reactor to doses up to 1.2×10^{21} (>1 Mev) and temperatures in the range 470–1200°C, at dose rates of 1 to 3×10^{14} nv. The results of x-ray measurements and optical and electron microscopy are presented and discussed. Comparisons are made with previously reported results on similar material irradiated in the reactor HIFAR at lower dose rates. (auth)

4711 (BMI-1698) AN EVALUATION OF PLUTONIUM COMPOUNDS AS NUCLEAR FUELS. William M. Pardue, Victor W. Storhok, Roy A. Smith, and Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). Oct. 29, 1964. Contract W-7405-eng-92. 37p. Dep.; $2.00(cy), 1(mn) OTS.

Nuclear and materials properties of interest were considered in defining the most attractive plutonium compounds for use in thermal and fast reactors. Some consideration was also given to the use of these compounds in radioisotope heat sources. After a process of elimination, the most promising compounds included PuN, PuO_2, PuC, PuS, PuP, $PuAl_2$, $PuSi_2$, PuAs, PuTe, and PuB. The first three listed are believed to possess approximately equal potential and next two to deserve further evaluation. Cursory experimental studies on the systems plutonium–arsenic, plutonium–phosphorus, and plutonium–silicon were carried out, and certain phase relationships were defined. Tentative phase diagrams of the arsenide and phosphide systems were drawn. Single-phase PuP specimens were prepared. (auth)

4712 (CEA-R-2588) RESULTATS NOUVEAUX SUR LE COMPORTEMENT DES GAZ DE FISSION A HAUTE TEMPERATURE DANS L'UO_2 EN PILE. (New Results Concerning the Behavior of Fission Gases in In-Pile UO_2 at High Temperatures). Rene Soulhier (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble) and Albert Schurenkamper (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). Aug. 1964. 61p. Dep.(mn).

In the first part, the various phenomena giving rise to the production of fission gases towards the exterior of nuclear fuels are considered. The following aspects are dealt with: diffusion, for which is considered the influence of the predecessors of the radioactive gases, fission recoil, atom expulsion along the fission paths, and evaporation. In the second part, the results obtained on UO_2 samples subjected to irradiation at temperatures of between 150 and 2000°C are presented. At low temperatures the variation of the amount produced as a function of the half life of the isotopes studied shows that recoil is not the only cause of gas production. Above 1800°C, a weight loss by evaporation has been observed and the influence of this phenomenon on gas liberation has been studied; thus the fraction of ^{135}Xe liberated at 2000°C by processes other than evaporation is of the order of 10 per cent. The influence of the various mechanisms on the overall effect as a function of temperature is discussed. (auth)

4713 (EURAEC-1063) SINTERED URANIUM OXIDE: SINTERING TECHNIQUE [AND] BEHAVIOR UNDER IRRADIATION. Quarterly Report No. 14, January 1–March 31, 1964. (France. Commissariat à l'Énergie Atomique, Paris). Work Performed under United States—Euratom Joint Research and Development Program. Contract 031-60-10-RDF. 32p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Results of a survey of sintered UO_2 out-of-pile heat conductivity including measurements under various gases are presented. It is concluded that the influence of filling gas depends on the lattice of fracturation and on the diametrical fuel-can clearance. Irradiation tests were made on the sintered UO_2 to compare the quantities of fission gas released at 970, 1115, and 1400°C and to compare the quantities released at 1400 and at 1850°C. The results obtained at 1400°C agree. A survey of the variation of the gas quantities released as a function of temperature was undertaken on monocrystalline UO_2 pebbles. A test was conducted to determine the quantity of gas released during an irradiation at 150°C. Other tests were made at 1400 and at 1500°C. The quantities of gas collected are smaller than those obtained during the irradiation of the sintered UO_2 samples. (auth)

4714 (HW-81334(Pt.2)) SELECTED MECHANICAL PROPERTIES OF IRRADIATED METALS AND ALLOYS. Spencer H. Bush (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1964. Contract [AT(45-1)-1350]. 118p. Dep.; $4.00(cy), 3(mn) OTS.

Data tabulations of mechanical properties are presented for the following irradiated metals and alloys: stainless

steels, Mg alloys, Al alloys, Be, Zr alloys, Ni-base alloys, Inconel-X, and Hastelloy-X. The data were used in another monograph to evaluate the state of the art in the field of irradiation damage to metals. (D.L.C.)

4715 (NRL-6151) IN-DEPTH EMBRITTLEMENT OF A SIMULATED PRESSURE VESSEL WALL OF A302-B STEEL. C. Z. Serpan, Jr., and L. E. Steele (Naval Research Lab., Washington, D. C.). July 16, 1964. 10p. (AD-606696). $0.50 (OTS).

Pressure vessel embrittlement by neutrons was investigated by the irradiation of a large block of A302-B steel at the core face of a pool reactor in a position simulating the pressure vessel location. The steel block, 6 in. thick, was made to accommodate five equally spaced assemblies of Charpy V-notch specimens which, in turn, represented the vessel material at comparable positions. The notch ductility test results of the irradiated specimens demonstrate a significant degree of embrittlement as well as a significant decrease in the degree of embrittlement through the simulated pressure vessel wall. However, the observed decrease is small when related to the respective variation in neutron dosage. A correlation of the notch ductility data developed in this study to that between test reactor experiments and in-service power reactor conditions is indicated. Neutron dosage values in terms of n/cm^2 (>1 Mev) determined for positions in the test block as well as similar positions in water alone form the basis for this correlation. Thus, the values obtained enhance the validity of the >1 Mev criterion for reporting neutron dose in radiation embrittlement studies. (auth)

4716 (NRL-Memo-1534) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. [Quarterly Progress Report], February 1, 1964–April 30, 1964. L. E. Steele, J. R. Hawthorne, and H. E. Watson (Naval Research Lab., Washington, D. C.). May 15, 1964. Contract AT-(49-5)-2110. 19p. (AD-602159) Dep.(mn); $0.50(cy), 1(mn) OTS.

Data are presented on the following: (1) simulation of periodic in-service annealing of pressure vessel steels for embrittlement relief, (2) surveillance of radiation embrittlement in Army SM-1A Reactor, and (3) equipment for in-reactor studies of low cycle fatigue performance of steels. (auth)

4717 (ORNL-3709) IRRADIATION TESTING OF FUEL FOR CORE B OF THE ENRICO FERMI FAST BREEDER REACTOR. W. C. Thurber, F. R. McQuilkin, E. L. Long, Jr., and M. F. Osborne (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 51p. Dep.; $3.00(cy), 1(mn) OTS.

Three instrumented capsules were irradiated in the MTR to assess the in-reactor performance of the fuel proposed for Core B of the Enrico Fermi Fast Breeder Reactor. Each capsule contained two miniature fuel plates, 2.0 × 0.5 × 0.116 in., comprised of an 0.102-in.-thick fuel-bearing section containing 33 wt % UO_2 dispersed in type-347 stainless steel and clad on both surfaces with 0.007-in.-thick type-347 stainless steel. Exposure conditions for the capsules included maximum average surface temperatures of 1005, 890, 945, 1000, and 1005°F, and burnup (fissions/cm^3) × 10^{21} of 1.7, 0.36, 0.39, 2.0, and 2.0. Some specimens were virtually unaffected by irradiation, exhibiting density decreases of approximately 0.5%. However, the specimens from other capsules suffered gross swelling and cracking of the stainless steel matrix, demonstrating that the burnup limits were clearly exceeded. Density decreases of 6 to 13% were measured for the specimens in these capsules. Correlation of these data with information developed by other experimenters suggests that at a surface temperature of 900°F the maximum tolerable burnup prior to failure will be less than 1.6×10^{21} fissions/cm^3. (auth)

4718 (ORNL-TM-1006 and Suppl.) PRELIMINARY REPORT ON THE RELEASE OF FISSION PRODUCTS ON MELTING GE-ANP FUEL. G. W. Parker, G. E. Creek, and W. J. Martin (Oak Ridge National Lab., Tenn.). Jan. 29, 1960. Contract W-7405-eng-26. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The initial experiments in the melting of Ge-ANP ceramic fuel tubes by the carbon arc-image process have been completed. Results of the first series of the experiments with the uncoated small cylindrical type fuel (LTC-14, 0.43% burnup) gave an average release of about 10 percent of the gross gamma activity, 73 percent of the gases, 70 percent each of the iodine and tellurium, 50 percent of the cesium, and 60 percent of the ruthenium. With an airflow of less than 1 foot per minute across the sample, approximately 90 percent of all the fission products (except the rare gases) plated out on the cold furnace tube in a coating of vaporized uranium and beryllium oxides. At an air flow of several feet per minute, this effect decreased to about 30 percent and most of the activity and metallic oxides passed through the furnace to the microfilters. Iodine diffused on past the filters to the special hot charcoal trap designed to retain it. Of the remaining fission products: the rare earths; the alkaline earths (Ba and Sr) and the refractory metals, less than 0.5% was released from the melt. The strontium value was approximately 0.15%. About 8 percent of the uranium was vaporized along with 1 percent of the BeO. Trace concentration of fission products (0.01% burnup) gave a somewhat diminished release rate compared to that observed after 0.43% burnup. (auth)

4719 (AEC-tr-6227/2(p.63-72)) RADIATION DAMAGE IN MOLYBDENUM AND TUNGSTEN IN HIGH NEUTRON FLUXES. S. Veljkovic and N. Milasin. Translated from Bull. Boris Kidrich Inst. Nucl. Sci., 15: No. 2, 63-72 (1964).

The effects of radiation on molybdenum and tungsten in high neutron fluxes are presented. The changes induced, particularly defects with a high migration activation energy, are analysed. The correlation of these changes with the basic concepts of radiation damage in solids is considered. An attempt is made to relate the defects studied with the changes in macroscopic properties. (auth)

4720 STUDY OF RADIATION EFFECTS BY MICROHARDNESS MEASUREMENTS. Ilse Schreiner and Karl Lintner (Universität, Vienna). Acta Phys. Austriaca, 18: 292-6(1964). (In German)

The effects of alpha and beta particles on the microhardness of cold-worked and soft-annealed Al samples were investigated. The curve of the microhardness within the sample was studied using electrolytic etching to expose successive layers of the sample. The effects of aging at room temperature and isochromic tempering were also studied. The results are given and discussed. (J.S.R.)

4721 EFFECTS OF CORPUSCULAR RADIATION ON THE RECRYSTALLIZATION OF VERY PURE ALUMINUM. H. Mayer and B. Weiss (Universität, Vienna). Acta Phys. Austriaca, 18: 297-303(1964). (In German)

The recrystallization phenomena of pure Al (99.996%) were investigated using photomicrographs, microhardness measurements, and electrical resistance measurements. The effect of corpuscular irradiation (alpha particles and neutrons) on the recrystallization process, particularly, was considered. It was shown that irradiation does not affect the recrystallization structure and that no measurable effect on the nucleus formation could be detected. However, the grain growth connected with nucleus formation could be partially disturbed by radiation defects, but only when the irradiation occurred at a critical state. This state is present when the nucleus formation is concluded, and the visible grain growth begins. As the calculation shows, the grain growth of irradiated samples is described by two activation energies. (tr-auth)

4722 A NEW MAGNETIC-FIELD ELECTRON-IRRADIATION TREATMENT FOR PRODUCING LOW-COERCIVE-FORCE RECTANGULAR HYSTERESIS LOOPS IN SUPERMALLOY. D. I. Gordon and R. S. Sery (Naval Ordnance Lab., Silver Spring, Md.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 105-10 (Nov. 1964).

The first true magnetic-annealing effects produced in a soft magnetic material through the medium of magnetic-field irradiation, were obtained by electron irradiation of

Supermalloy (5% Mo–80% Ni–15% Fe) at low temperatures (~100°C) in a magnetic field. Hysteresis loops, with high remanence and rectangularity, with no increase in coercive force, were obtained by this treatment. Previous magnetic-field irradiations resulted in increased coercive force. The similarities and differences between magnetic-field annealing and magnetic-field irradiation, the details of the new magnetic-field electron-irradiation treatment of Supermalloy, and the advantages of this treatment over magnetic-field neutron-irradiation and thermal treatments are discussed. An interpretation of the results in terms of directional-order theory is also given. (auth)

4723 COMBINED ENVIRONMENTS VERSUS CONSECUTIVE EXPOSURES FOR INSULATION LIFE STUDIES. F. J. Campbell (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-11: No. 5, 123-9(Nov. 1964).

An apparatus was designed that achieves a combined environment of both thermal and nuclear radiation. Results showed that by combining radiation with heat the normal thermal life of several materials was increased by as much as 800%, and for one of these materials the increase was over 3500% in one combination of radiation and heat. It is speculated that this is due to a balancing of the chain-scission and crosslinking mechanisms that occur in polymer reactions. The materials studied included polypyromellitimide, polyester, polyvinyl formal, silicone, and polytetrafluoroethylene. Data are tabulated. (P.C.H.)

4724 CARRIER LIFETIME STUDIES IN ELECTRON- (10-55 Mev) AND PROTON-(25-110 Mev) IRRADIATED GERMANIUM. J. E. Fischer and J. C. Corelli (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 35: 3531-6 (Dec. 1964).

Samples of single-crystal germanium were irradiated at room temperature with electrons of energies from 12 to 55 Mev and with protons of energies from 25 to 109 Mev. Measurements of the minority carrier lifetime as a function of flux and initial carrier concentration suggest that: (1) More than one recombination level, active at room temperature, is introduced in the forbidden gap by the defects created during electron and proton bombardment, with the multilevel effect being greater for the proton-irradiated specimens. (2) The carrier lifetime change with increasing proton energy does not decrease as sharply as predicted by Rutherford scattering and the Kinchin–Pease model. This indicates that nuclear elastic and inelastic processes must be included in computing the number of primary knockons created by protons of energies above at least 50 Mev. (3) The energy dependence of carrier lifetime change in the case of electron bombardment is complicated by a non-constant contribution of multiple levels to the recombination process in the electron energy range studied. At 12 Mev the behavior is adequately represented by single-level theory and a value of 15.4 displacements/cm is obtained. (auth)

4725 LOW-ENERGY ELECTRON DIFFRACTION STUDY OF GRAPHITE. J. J. Lander and J. Morrison (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 3593-8(Dec. 1964).

A low-energy electron diffraction study of surface properties of single-crystal graphite revealed that unlike silicon, germanium, or diamond, the basal plane at the surface was not reconstructed nor did it chemisorb H_2O, O_2, CO, Br_2, or I_2 in monolayer quantities at low pressures and moderate or high temperatures. Elastic and inelastic electron scattering factors for graphite and their contributions to diffraction effects were also evaluated. The layered structure serves to simplify certain analytical problems and, in particular, results in an energy region from about 10 to 70 v where one-dimensional analysis provides first-order estimates of these scattering factors. But it is also seen that from the point of view of complete and precise quantitative analysis, the elastic and inelastic scattering amplitudes, phase effects, three-dimensional effects and dynamic factors are almost inextricably entangled in the energy region below about 70 v. Above this region the diffraction effects are largely kinematic and analysis is much simpler. (auth)

4726 RADIATION HARDENING IN MILD AND LOW-ALLOY STEELS. D. R. Harries, A. G. Ardy, and A. F. Bartlett. J. Iron Steel Inst. (London), 202: 518-22(June 1964). (AERE-R-4407)

Tensile specimens of an Al grain size controlled mild steel and a low-alloy steel were irradiated in a reactor at about 30°C to a dose of 1.72×10^{18} n/cm^2 (fission), annealed for 1 hr at temperatures up to 400°C, then tested at room temperature. Effects on the lower yield stress, ultimate stress, elongation to fracture, and rate of work hardening were determined. (Rev. Metal Lit., 21: No. 10, Oct. 1964)

4727 IRRADIATION TEST ON SWAGED UO_2 FUEL. IV. METALLOGRAPHY AND THE ESTIMATION OF CENTER TEMPERATURE. Shuichiro Takahashi, Yoshinobu Seki, Tadashi Kubota, Yutaka Honda, and Tadahide Nohara (Mitsubishi Atomic Power Industry, Inc., Japan). Nippon Genshiryoku Gakkaishi, 6: 569-75(Oct. 1964). (In Japanese)

The irradiation behavior of swaged UO_2 fuel is described. Results obtained by post-irradiation tests concerning metallography and the estimation of center temperature are reported. The mechanism of the sintering phenomenon in swaged rods was confirmed by optical microscope, although appreciable grain growth was not identified. The center temperature during irradiation was estimated to be 1,300 to 1,600°C. The mean thermal conductivity of UO_2 was estimated to be 1.5 to 2 Btu/hr ft°F. (auth)

4728 THE ANNEALING OF NEUTRON IRRADIATION HARDENING IN COPPER CRYSTALS. M. J. Makin and S. A. Manthorpe (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 10: 579-94(Oct. 1964). (AERE-R-4538)

The thermal annealing of the principal parameters of the stress-strain curve of neutron-irradiated copper crystals is described. The parameter most sensitive to annealing is the Lüders extension at 20°C, which is substantially reduced by anneals that have little effect on the critical shear stress. The other two parameters which recover more rapidly than the critical shear stress at 20°C are the critical shear stress at −195°C and the stress at which stage III commences at 20°C. The rate of hardening in stage II at 20°C is reduced by irradiation and is unusual in that it recovers only after the critical shear stress at 20°C has been reduced to approximately half the irradiated value. Activation energies were measured for the recovery of the Lüders extension (1.5 ev increasing to 2.3 ev as recovery proceeds) and the critical shear stresses at −195°C (1.9 ev increasing to 2.5 ev) and 20°C (2.2 ev). These results can only be satisfactorily interpreted in terms of a spectrum of irradiation-produced defect clusters. Very small clusters appear to have a very important effect on both the critical shear stress at −195°C and the Lüders extension at 20°C; larger clusters control the critical shear stress at 20°C. For this reason empirical relations between the various parameters are unlikely to have any general application. A model is proposed to reconcile the apparent anomaly of easy cross slip in stage I with an increased stress for the onset of stage III. (auth)

4729 STRENGTH-ANNEALING STUDIES IN NEUTRON-IRRADIATED COPPER-BASE ALLOY SINGLE CRYSTALS. T. J. Koppenaal (Argonne National Lab., Ill.). Phil Mag. (8), 10: 651-8(Oct. 1964).

The yield stress of neutron-irradiated αCu–Al, αCu–Ga and αCu – Ge single crystals were studied during isochronal annealing from 100 to 450°C. The temperature needed to achieve a given stage in the annealing decreases with increasing solute additions. The return of the pre-irradiated strength in alloys containing 14 at. % Al, 14 at. % Ga, and 7 at. % Ge occurs at temperatures in the range from 200 to 350°C, rather than in the 300 to 450°C interval found for pure copper. The strength of Cu – 14 at. % Al crystals was determined as a function of isothermal annealing at temperatures from 221 to 304.5°C. Activation energies were calculated from these data, and these are compared to values obtained elsewhere for pure copper crystals. Possible reasons are discussed for the decrease in this energy due to the solutes. (auth)

4730 STIMULATED MIGRATION OF POINT DEFECTS DUE TO ELECTRON BOMBARDMENT IN THE ELECTRON MICROSCOPE, AND ITS POSSIBLE EFFECT ON THEIR CLUSTERING. R. S. Nelson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 10: 723-6(Oct. 1964). (AERE-M-1372)

It is shown that the maximum energy (~ 4 ev) transferred by a 100-ev electron to a copper atom in a foil is insufficient to produce a permanently displaced atom, but is sufficient to move a pre-existing point defect. The effect of stimulated migration on the aggregation of point defects is considered. (D.C.W.)

4731 INTERACTION BETWEEN POINT DEFECTS AND Sn ATOMS IN NEUTRON IRRADIATED Al–Sn ALLOY. S. Ceresara (Istituto Sperimentale Metalli Leggeri, Novara, Italy), T. Federighi, and F. Pieragostini. Phil. Mag. (8), 10: 893-7(Nov. 1964).

The effects of Sn on the recovery of the extra resistivity induced in Al by neutron irradiation at liquid nitrogen temperature were studied. The results support the hypothesis that vacancy-type defects are mobile in the second recovery stage. The vacancy concentration was estimated, together with the interaction energy. (D.C.W.)

4732 NOTE ON THE PAPER OF CERESARA, S., FEDERIGHI, T., AND PIERAGOSTINI, F. ENTITLED: "PRE-PRECIPITATION RATE IN Al–10% Zn ALLOY NEUTRON-IRRADIATED 78°K." W. Schuele (C.C.R., Euratom, Ispra, Italy). Phil. Mag. (8), 10: 913-15(Nov. 1964).

It is shown that pre-precipitation of Zn, to which the electrical resistance increase observed between –100 and –20°C after irradiation at 78°K was attributed, is better explained by assuming free interstitial diffusion. (D.C.W.)

4733 EFFECTS OF AUTO-IRRADIATION ON THE LENGTH OF A POLYCRYSTAL OF α PLUTONIUM. P. Solente and R. Lallement (CEN, Fontenay-aux-Roses, France). Phys. Letters, 13: 109-10(Nov. 15, 1964). (In French)

The elongation of a bar of alpha plutonium was measured after auto-irradiation in liquid helium at 4.2°K. The elongation rate was determined and was estimated in good agreement with the measurements by considering Frenkel pair creation with a small negative contribution due to spin disordering by auto-irradiation. (D.C.W.)

4734 LENGTH CHANGE OF ELECTRON-IRRADIATED GERMANIUM. J. C. North and R. C. Buschert (Purdue Univ., Lafayette, Ind.). Phys. Rev. Letters, 13: 609-11 (Nov. 23, 1964).

Length and electric conductivity changes were observed in degenerate n-type Ge single crystals during bombardment with 4.5-Mev electrons at liquid helium temperature and during subsequent isochronal annealing. An interpretation of the observed length contractions in terms of an electronic effect that dominates over the expansions caused by atomic effects is proposed. The length changes observed in p-type Ge irradiated under similar conditions were smaller by more than an order of magnitude. (D.C.W.)

4735 RADIATION RESISTANCE OF AROMATIC AND ARYLALIPHATIC POLYAMIDES. M. L. Kerber, O. Ya. Fedotova, and I. P. Losev. Plasticheskie Massy, No. 4, 20-3(1964).

The radiation resistance of aromatic, aliphatic, and arylaliphatic polyamides was investigated. The radiation resistance of polyamides (poly-p-phenyleneterephthalamide, poly-p-phenylenesebacinamide, polydiphenyl-methaneterephthalamide, polyditolylmethaneterephthalamide, and poly N,N'-dimethyl-[(diphenylmethane)-terephthalamide]) was determined by the change in molecular weight (specific viscosity) and the thermomechanical properties under the effect of gamma irradiation. The polyterephthalamides were most resistant to gamma radiation; they were also resistant to oxidative destruction at 200°C. The predominance of the destruction processes showed up at different integral doses depending on the structure of the backbone of the aromatic polyamides. The parallel course of the processes of degradation and cross linking of polyamides by gamma radiation in air was thus confirmed. Exchanging the aromatic group of the amide for an aliphatic or arylaliphatic reduced the radiation resistance of the polymer. (OTS)

4736 IRRADIATION EFFECTS OF NEUTRONS ON HIGH PERMEABILITY FERRITES. E. Labusca, N. Andreescu, and C. Motoc. Rev. Roumaine Phys., 9: 419-30 (1964). (In French)

The effects of neutron irradiation on the magnetic properties and the crystal structure of two types of ferrites of the system Fe_2O_4Zn - Fe_2O_4Mn - $Fe_2O_4Li_2$ were investigated. The observed effects were different for the two types of ferrites. The observed modification of the magnetic properties was explained by the modification of the degree of crystal structure order due to radiation defects. (D.C.W.)

4737 EFFECT OF GAMMA IRRADIATION ON THE ELECTRON WORK FUNCTION FOR THE OXIDIZED SURFACES OF PLATINUM, GOLD AND ZINC IN THE PRESENCE OF OXYGEN. Juliusz Siejka (Inst. of Nuclear Research, Warsaw). Z. Physik. Chem. (Leipzig), 226: 351-9(1964).

The effects of oxygen pressure caused by gamma irradiation on the electron work function (ewf) of Pt, Au, and Zn were determined. Measurements of ewf before and after irradiation were performed in a vacuum at 10^{-5} mm Hg. By irradiation of the plates with the same ewf value, decrease of ewf values at low pressures and increase of ewf values at high pressures of oxygen were observed. The oxygen pressures at which the change of irradiation effect occurs depends on the ewf values of the nonirradiated plates. The results showed that the physical adsorption of oxygen in room temperature on Au and Zn plates is reversible. A second decrease of oxygen pressures from 100 to 10^{-5} mm Hg reached the same ewf value. (P.C.H.)

4738 RADIATION EFFECTS ON TEFLON AND TEFLON-BASED MATERIALS AT LIQUID-HYDROGEN TEMPERATURES. W. Weleff, H. S. McQueen, and W. E. Emmons (Aerojet-General Corp., Sacramento, Calif.). 25p. (CONF-446-62)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Studies were made on the effects of different radiation doses on tensile strength, elongation, and area reduction of Teflon (TFE), Armalon (a laminate of glass cloth impregnated with Teflon), and Rulon A (fiber-filled Teflon) while they were immersed in liquid hydrogen. Stress-strain diagrams were obtained for each specimen and each material. The ultimate strength was not affected by the radiation exposures given to the specimens. However, a definite trend was apparent in the elongation data as a function of exposure: the elongation decreased with increasing dose level, showing a tendency toward brittle behavior. Changes in microstructure were noted in the case of Armalon. A color change was noted in the case of Rulon A. Based upon the observed tensile strength and elongation, and different levels of irradiation, the TFE appears usable for applications in a liquid hydrogen environment at radiation doses up to 5×10^8 ergs/g. (P.C.H.)

METEOROLOGY

Refer also to abstract 4369.

4739 GLOBAL HISTORY OF THE 1958 NUCLEAR DEBRIS AND ITS METEOROLOGICAL IMPLICATIONS. K. Telegadas and R. J. List (Weather Bureau, Washington, D. C.). J. Geophys. Res., 69: 4741-53(Nov. 15, 1964).

Radioactive debris injections into several parts of the stratosphere in 1958 serve as tracers for stratospheric motions. Aircraft observations to 21 km over much of the northern hemisphere and balloon observations to 30 km at 45 and 31°N suggest that debris injected at very great heights, above 43 km, over the equatorial regions descends into the polar stratosphere and is subsequently propagated downward and equatorward. North of 35°N between 14 and 20 km the downward movement in the winter months is of the order of 1.5 km per month, and it is suggested that mass movement rather than vertical diffusion is the dominant mechanism. Debris injected into the lower equatorial stratosphere appears to be governed by mixing phenomena to about 35°N, but no simple model explains the distribution found over more northerly regions. (auth)

PHYSICS

General

4740 (GA-5744) THE NATURE OF HYDROGEN MOTION IN ZrH DETERMINED FROM AN EXPERIMENTAL NEUTRON STUDY OF LARGE, BOUND ENERGY LEVELS. William L. Whittemore (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 7, 1964. Contract AT(04-3)-167. 16p. (CONF-804-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

For presentation at Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The neutron velocity selector has been used to select monoenergetic neutrons with energy ranging up to about 1.0 ev for a study of the motion and binding of hydrogen in zirconium hydride. Differential scattering measurements have been made for a variety of incident energies and at laboratory angles of 30, 60, 90, and 120°. The resolution of the incident energy was of the order of 6 per cent for the highest energies used and was better for the lower energies. If the motion of the hydrogen atoms is harmonic, even though not isotropic, the differential angular quasi-elastic scattering depends in a simple manner on the momentum transfer. The experimental measurements lead to verification of the predicted dependence for $ZrH_{0.5}$ and $ZrH_{2.0}$ and indicate that the shape of the potential well is nearly quadratic at least for the ground state. With the higher incident energies, simultaneous excitation of bound harmonic levels has been observed up to the fourth level. Roughly equal spacing for these excited levels is observed as is necessary but not sufficient for a harmonic potential. A sensitive test of the shape of the potential well for the higher bound levels is provided by the present experimental study of (1) the angular dependence of the scattering which leads to excitation of the higher levels, (2) the width of the first and second excited levels, and (3) the temperature and angular dependence of the level widths. These various studies have led to the conclusion that the potential well is still nearly quadratic for the first excited level but deviates therefrom for the higher bound levels. The specific angular and temperature variations of the level widths are not explained by a simple harmonic potential. (auth)

4741 (IS-1033) NÉEL TEMPERATURES OF CHROMIUM–VANADIUM ALLOYS FROM NMR MEASUREMENTS. R. G. Barnes and T. P. Graham (Ames Lab., Ames, Iowa). Oct. 28, 1964. Contract [W-7405-eng-82]. 9p. (CONF-794-1) Dep.(mn); $1.00(cy), 1(mn) OTS.

From Magnetism Conference, Minneapolis, Nov. 1964.

The antiferromagnetic transition temperature of chromium-rich V–Cr alloys was investigated by means of the extinction of the ^{51}V and ^{53}Cr NMR signals at the transition temperature in these alloys. Measurements on both natural and isotopically enriched ^{53}Cr chromium yield $T_N = 39.0 \pm 0.5°C$, in excellent agreement with neutron diffraction results. T_N decreases roughly linearly with V content, falling below 4.2°K at 3.4% V. In all cases, the resonance intensity follows the empirical behavior, $I = I_0 \tanh K(1 - T_N/T)$, where $K \approx 15$. At temperatures well above T_N the line width and second moment of the ^{53}Cr resonance are appreciably larger than the calculated values based solely on nuclear dipolar broadening. These results might be attributed to the persistence of a very small electronic moment in the paramagnetic state. (auth)

4742 (LNF-64/30) ALCUNI ASPETTI DELLA FOTOCONDUZIONE NELLE POLVERI MICROCRISTALLINE DI CdS. (Some Aspects of the Photoconduction of Microcrystalline Powders of CdS). Note No. 248. L. Bartolini (Italy. Comitato Nazionale per l'Energie Nucleare. Laboratori Nazionali, Frascati). June 24, 1964. 11p. Dep.

The technique used for the preparation of photoconducting microcrystalline powders of CdS is described. Some measurements are reported on the response time and the dependence of the photocurrent on the voltage applied to the photocell and on the incident light flux. (tr-auth)

4743 (NP-14444) ION ROCKET ENGINE FLIGHT TEST, DEVELOPMENT, AND SUPPORTING RESEARCH. Quarterly Progress Report No. 2, January 14–April 13, 1964. (Hughes Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). June 29, 1964. Contract NAS 3-4109. 202p.

Progress in the SERT-I flight test program is reported. Design and development of ion rocket engines are described along with ion engine research and evaluation. (J.R.D.)

4744 (SC-DC-64-1006) PULSED, NONUNIFORM FIELD ELECTRIC STRENGTH OF A HIGH POLYMER. J. L. Wentz (Sandia Corp., Albuquerque, N. Mex.). [Oct. 1964]. Contract [AT(29-1)-789]. 9p. (CONF-769-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

A cable discharge system is described for studying the electrical breakdown of an amorphous solid. A pin electrode configuration is used, and the operation of the system is discussed. Breakdown data are presented and discussed for SRIR epoxy material. (D.L.C.)

4745 (ANL-Trans-131) EFFECTS OF IMPURITIES ON THE ELECTRONIC DENSITY IN METALS (thesis). Emile Daniel (Paris. Universite). Translated by D. O. Van Ostenburg, P. Tobin, and R. R. Inston (Argonne National Lab., Ill.). 1959. 73p. Dep.(mn); $7.60(fs), 2.39 (mn) JCL.

A study was made of the approximations used in the theoretical interpretation of experiments on metals and alloys. The Knight shift in the nuclear resonance frequency is explained in quantitative terms. The validity of the square-well potential representation of the effect of a substitutional impurity in a metal was studied. A Coulomb potential with screening was used to calculate the lifetime of a positron in copper and the electronic density at the Fermi level for a positive muon stopped in a metal. The substitutional impurity model shows that the emission spectra image in the conduction band is distorted. (D.L.C.)

4746 (FTD-TT-64-1077(p.191-9)) THE POSSIBILITY OF CAPTURING CHARGED PARTICLES IN THE FIELD OF A MAGNETIC DIPOLE IF ENERGY IS LOST AS A RESULT OF EMISSION. V. M. Vakhnin and I. N. Shvachunov. Translated from Kosmich. Issled., 2: 773-8(1964).

The possibility of capturing charged particles in the field of a magnetic dipole was studied for arbitrary three-dimensional particle motion. Use is made of a method of phase trajectories in a four-dimensional phase space. It is demonstrated that the "critical trajectories" and the possibility of capture exist in three-dimensional motion as well. (auth)

4747 HYDROMAGNETIC HEAT TRANSFER IN THE THERMAL ENTRANCE REGION OF A CHANNEL WITH ELECTRICALLY CONDUCTING WALLS. M. K. Jain and J. Srinivasan (Indian Inst. of Tech., Kharagpur). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1886-92(Nov. 1964).

The temperature distributions and heat transfer in the thermal entrance region, which results when a viscous, incompressible electrically conducting fluid flowing steadily in the presence of a transverse magnetic field between parallel electrically conducting walls, which are kept at a constant temperature up to a certain cross section, enters a region with a different wall temperature, are analyzed. Solutions were obtained in terms of eigenfunctions and eigenvalues for two cases corresponding to a small value of the Peclét number and an infinite value. It is found that downstream temperature conditions do not have any effect upon the upstream temperatures to the left of the transition

cross section when the Peclét number is large, whereas for a small Peclét number, this ceases to be so. Thermal entry lengths are seen to be diminished by the increase in conductivity conditions of the walls. (auth)

4748 LAMINAR JET AGAINST A WALL IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Rene Moreau (Universite, Grenoble, France). Compt. Rend., 259: 2177-80(Oct. 5, 1964). (In French)

It is shown that an exact affine solution can exist, at most, only for certain monomial distributions of the magnetic field. On the contrary, an approximate relation is justified for an arbitrary distribution. In the particular case of a uniform magnetic field, calculations were achieved with this hypothesis. (tr-auth)

4749 NUCLEAR RESEARCH IN CZECHOSLOVAKIA. F. Klik, P. Kovanic, and L. Berak (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Euro Nucl., 1: 34-8(Sept. 1964).

Research and scientific work by the Czechoslovak laboratories in the field of the peaceful uses of atomic energy have led to some interesting results. These are particularly important in the investigation of decay schemes of neutron-deficient rare earth isotopes, dynamic polarization of nuclei by high-frequency methods, theory of heterogeneous media, heat transfer intensification using ionization in a reactor, the conception of heavy-water gas-cooled reactors, fully-automatic reactor control, the separation of some elements from the bulk of fission products, radioactive waste disposal, radiation dosimetry, induction accelerators, and several other research activities. A description of some of the equipment and facilities available, and some of the results obtained in the investigation of automatic reactor control and in the management of low-activity liquid wastes are presented. (auth)

4750 THE GENERALIZED MAGNETOHYDRODYNAMIC JEFFERY-HAMEL PROBLEM. M. Emin Erdogan (Technical Univ. of Istanbul). Istanbul Tek. Univ. Bul., 16: No. 2, 53-8(1963).

The steady flow of an electrically conducting, incompressible viscous fluid between two plane walls meeting at angle 2α in the presence of a magnetic field produced by an infinitely long wire placed on the line of intersection of the channel walls is considered. The velocity fields are $v_r = u(\theta)/r$, $v_\theta = 0$, $v_z = \omega(\theta)/r$ (r, θ, z being cylindrical polar coordinates). The general MHD equations are simplified by the conditions of the problem to a system of the non-linear differential equations. Two methods for the solution of this system are outlined. (auth)

4751 CONFERENCE ON OPACITIES. Proceedings of a Symposium Held at Kirtland Air Force Base, Albuquerque, New Mexico, April 1963. Harris L. Mayer, ed. J. Quant. Spectry. Radiative Transfer, 4: 585-761(Sept.-Oct. 1964). (CONF-431)

The topics discussed include opacity calculations, screened hydrogenic wave functions, model interactions in atomic spectroscopy, level shift and level width in hydrogenic plasma, interdependent electrons in the screening constant model of the many-electron-atom, a variational principle for off diagonal matrix elements, Stark broadening calculations, Stark coupling of radiation and plasma oscillations, collective effects in atomic spectra, plasma-electromagnetic radiation interaction, band absorption model for arbitrary line variance, Kubo response functions for radiative transport, non-grey radiative transfer, opacity of high-temperature air, and opacities for astrophysics. Separate abstracts are prepared for 8 of the 15 papers presented. Abstracts of 3 papers previously appeared in NSA (18: 14701, 20731, and 30404). (C.E.S.)

For abstracts of individual papers see: 4752, 4753, 4754, 4755, 5025, 5321, 5322, and 5323.

4752 APPLICATION OF KUBO RESPONSE FUNCTIONS TO RADIATIVE TRANSPORT. Edwin T. Florance (Geophysics Corp. of America, Bedford, Mass.). J. Quant. Spectry. Radiative Transfer, 4: 713-21(Sept.-Oct. 1964).

The semi-classical radiative transport equation is derived, and the absorption coefficient is determined from the dielectric loss by using Kubo theory. The fluctuation–dissipation theorem is applied to obtain the field fluctuations in terms of the imaginary part of the retarded Maxwell Green's function. The generalized quantum action principle developed by Schwinger is utilized to derive the equations of motion for the quantum Maxwell Green's functions. To decouple matter and radiation, the current response functions, or polarization tensors, are approximated by current–current correlation functions. The retarded Green's function is found to be identical with the classical expression. Possible uses of this theory to describe masers and non-equilibrium radiative transfer are discussed. (auth)

4753 NON-GREY RADIATIVE TRANSFER. John C. Stewart (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Quant. Spectry. Radiative Transfer, 4: 723-9(Sept.-Oct. 1964).

An approach to problems of macroscopic radiative transfer in media whose photon absorption coefficients depend strongly on frequency (non-grey problems) is suggested. A method for solving certain non-grey problems exactly is described, and numerical results of the method are presented. (C.E.S.)

4754 RESEARCH ON OPACITY OF HIGH-TEMPERATURE AIR. Baxter H. Armstrong (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Quant. Spectry. Radiative Transfer, 4: 731-6(Sept.-Oct. 1964).

A summary of work in progress and a review of past work on determining the opacity of high-temperature air are presented. Statistical mechanics and atomic physics of the absorption cross sections are discussed. (C.E.S.)

4755 REVIEW AND SUMMARY OF OPACITY CALCULATIONS. Walter F. Huebner (Los Alamos Scientific Lab., N. Mex.). J. Quant. Spectry. Radiative Transfer, 4: 753-60 (Sept.-Oct. 1964). (LADC-6348)

An outline is presented of relevant methods and theories emphasizing the main contributions to Rosseland mean opacities in widely differing temperature and compression ranges for widely different elements and mixtures. (auth)

4756 A MICRO-EVAPORATION SOURCE HEATED BY ELECTRON BOMBARDMENT AND ITS UTILIZATION FOR TARGET PREPARATION IN NUCLEAR PHYSICS. W. Menti, M. Martin, E. B. Bas, and O. Vogt (Eidgenössische Technische Hochschule, Zurich). Nucl. Instr. Methods, 31: 25-8(Dec. 1, 1964).

A micro-evaporation source is described, which allows the evaporation of very small amounts of substance with good yields, for example in the preparation of isotope targets for nuclear physics experiments. A very small crucible with a small exit orifice is heated by electron bombardment. The heating circuitry, the temperature calibration curves for various crucible arrangements, and an example of the attainable homogeneity of the evaporated films are included in the description. (auth)

4757 HYDROMAGNETIC STABILITY OF A VORTEX SHEET IN COMPRESSIBLE FLUIDS. K. C. Wang and S. H. Maslen (Martin Co., Baltimore). Phys. Fluids, 7: 1780-4 (Nov. 1964).

The stability of a vortex sheet between two compressible, perfectly conducting fluids in the presence of uniform, parallel magnetic fields is examined. The ratio between the Alfvén speed and the sound speed is shown to play an important role. In particular, when this ratio is equal to unity in both media, a vortex sheet can be completely stable. (auth)

4758 EXCITATION OF HYDROMAGNETIC WAVES IN A HIGHLY CONDUCTING LIQUID. Nicholas Gothard (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 7: 1784-8 (Nov. 1964).

A study is made of the propagation of hydromagnetic waves along a circular stainless steel waveguide filled with a fluid (Nak 78), and subject to a steady magnetic field

parallel to the guide. The dependence of wavelength and input impedance on frequency was calculated theoretically and confirmed experimentally. The excitation and detection arrangements used are described. (auth)

4759 MAGNETOHYDRAULIC JUMP. Nima Geffen (Israel Inst. of Tech., Haifa). Phys. Fluids, 7: 1868-70 (Nov. 1964).

An analysis is presented of standing discontinuities (magneto-hydraulic jumps) in one-dimensional flow of an inviscid liquid of infinite electric conductivity in a two-dimensional channel with a longitudinal magnetic field. (T.F.H.)

4760 CORRELATION EFFECTS AND THE HELICON DISPERSION RELATION. R. E. Prange (Univ. of Maryland, College Park). Phys. Letters, 12: 181-2(Oct. 1, 1964).

The model of metals based on the Froelich hamiltonian of the electron–phonon interaction is treated within the generalized Landau Fermi-liquid theory. The distribution functions for the quasi-particles, as well as expressions for the energy levels as functions of the distribution functions, are written. These expressions are used to determine the helicon dispersion relation, and to show that there are no interaction corrections to this relation. (T.F.H.)

4761 ELECTRON-ELECTRON INTERACTION IN EFFECTIVE MASS EQUATION. A. Weissmann and I. Stan (Babes-Bolyai Univ., Cluj). Phys. Letters, 12: 196-8 (Oct. 1, 1964).

A calculation is carried out of the effective-mass equation for electrons in semiconductors, taking into account long-range electron–electron interactions, which are not insignificant at sufficiently high frequencies. (T.F.H.)

4762 IRREVERSIBLE PHENOMENA IN A QUANTUM GAS. C. George (Université Libre, Brussels). Physica, 30: 1725-45(Sept. 1964). (In French)

The behavior of a dilute quantum system of discernible particles is studied in the approximation of weak coupling. It is shown, on a detailed simplified example, that the major difference with the analogous classical system as studied by Prigogine and his coworkers rests in the appearance of a characteristic quantum time of the order $\tau_{DB} = \Lambda_{DB}/\bar{v}$, where Λ_{DB} is the thermal De Broglie wavelength and $\bar{v}$ the mean velocity of the particles. The form of the collision time $\tau_c = \Lambda/\bar{v}$, where Λ is the effective range of the interaction, is unaffected by the quantization, but there appears aside a typical quantum oscillation. For times which are long with respect to these characteristic times, the evolution of the system is Markovian. (auth)

4763 RADIAL DISTRIBUTION OF THE POSITIVE IONIC DENSITY OF THE CATHODE SURFACE OF A D.C. GLOW DISCHARGE. V. T. Chiplonkar and S. N. Joshi (Inst. of Science, Bombay). Physica, 30: 1746-56(Sept. 1964).

The radial distribution of the positive ions on the cathode surface of a cold cathode glow discharge in hydrogen was determined over a wide range of discharge parameters ($p = 500 - 30$ microns, $I_c = 0.5 - 6$ mamp) such that the discharge varies from the near normal to the obstructed type. The results show that for $p = 200$ microns, the distribution is of the flat type with negligible edge effects, for $p = 200 - 75$ microns a significant edge effect with a Gaussian distribution is observed. For still lower pressures the overall distribution is Gaussian. The concentration of the current density towards the axis was attributed to the wall potential developed due to the diffusion of the positive ions in the dark space. This was confirmed by determining the effect of introducing an additional wall in the dark space and of a longitudinal magnetic field, on the radial distribution. (auth)

4764 SELF-EXCITATION OF A MAGNETIC FIELD DURING THE MOTION OF A HIGHLY CONDUCTING FLUID. S. I. Braginskii. Zh. Eksperim. i. Teor. Fiz., 47: 1084-98(Sept. 1964). (In Russian)

The Cowling theorem on the impossibility of an axially symmetric stationary hydromagnetic dynamo is extended to the non-stationary case. Equations are derived for the axial symmetric magnetic field components in the presence of small deviations from axial symmetry. If the conductivity is high the deviation leads to the appearance of a self-excitation effect; as a result a term proportional to the azimuthal field appears in the equation for the meridian field vector potential. An expression for the corresponding proportionality coefficient (called the generation coefficient) is derived in terms of velocity components depending on the azimuth. The behavior of the field near surfaces at which the (tangential) velocity experiences a discontinuity is also considered. Thin transition layers are produced near such surfaces; generation in such layers is greatly enhanced and an effect of concentrated generation arises. A similar phenomenon may also arise in layers near surfaces for which the azimuthal velocity vanishes. Both types of layers are considered and expressions are obtained for the corresponding coefficients of concentrated generation in them. Surface layers produced at the outer boundary of a liquid conductor in which self-excitation of the field arises are also considered. (auth)

4765 CASCADE IONIZATION OF A GAS BY A LIGHT PULSE. Ya. B. Zeldovich and Yu. P. Raizer. Zh. Eksperim. i Teor. Fiz., 47: 1150-61(Sept. 1964). (In Russian)

The mechanism of ionization of a gas under the action of a light pulse is considered. The case is investigated when the pulse power and electric field strengths in the light wave are not very large and the light-induced emission of electrons is not of decisive importance. Under these conditions ionization is of a cascade nature; the electrons absorb light quanta in collisions with neutral atoms and accumulate energy sufficient for ionization. Approximate calculations of the kinetics of development of the cascade are carried out by taking into account the most important processes. Results of calculation of the breakdown fields are compared with published experimental data. (auth)

4766 MOTION OF VISCOUS CONDUCTING FLUID IN RECTILINEAR PIPES UNDER TRANSVERSE MAGNETIC FIELDS. G. A. Grinberg (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1721-31(Oct. 1964). (In Russian)

Studies were made of fluid flow in a tube of arbitrary cross section and with nonconducting walls. The problem was reduced to Green's functions for the two-dimensional equation $\Delta\psi - M^2\psi = 0$ and the corresponding region (M is the Hartman number) when the velocity (v) and the induced magnetic field (H) are parallel to the axis of the tube. The integral equation for the normal to the contour of the Green's function derivative summed the solution in squares. A rapid convergence of consequent approximations was found for large M, and an asymptotic solution was obtained for an integral equation used for finding the v and H values at any point inside of the tube. Precise Green's functions were found for a rectangular tube. (tr-auth)

4767 ON THE OBLIQUE SHOCK WAVES IN MAGNETOHYDRODYNAMICS. R. V. Polovin. Zh. Tekhn. Fiz., 34: 1798-1802(Oct. 1964). (In Russian)

Limitations imposed by evolution and "sweeping-out" conditions on various oblique shock waves in magnetohydrodynamic flow were investigated for the case in which the magnetic field is parallel to the flow. It is shown that only one shock wave can be associated with the apex of the streamline angle. (tr-auth)

4768 SOME REMARKS ABOUT STATIONARY MAGNETOHYDRODYNAMIC TURBULENCE. L. S. Marochnik (Inst. of Astrophysics, Tadzhik SSR). Zh. Tekhn. Fiz., 34: 1852-5(Oct. 1964). (In Russian)

It is shown that the Batchelor criterion in stationary magnetohydrodynamic turbulence takes place with arbitrary magnetic fields (tr-auth)

4769 MÖSSBAUER QUADRUPOLE RESONANCE IN Fe^{57} SINGLE CRYSTALS. Peter S. Zory, Jr. (Carnegie Inst. of Tech., Pittsburgh). 78p. (CONF-303-20)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

A general method was developed that utilizes the intensity ratio to determine the five parameters of the electric field gradient (EFG). The method was applied to $FeCl_2 \cdot 4H_2O$, and the measured EFG parameters were utilized to determine the crystalline ground state wave function of the ferrous ion in this salt. (P.C.H.)

Accelerators

Refer also to abstracts 4515 and 4518.

4770 (AED-C-18-02) BESCHLEUNIGER. BIBLIOGRAPHIEN. (Accelerators. Bibliographies). W. Mausberg, comp. (Frankfurt am Main. Universität. Institut für Kernphysik). June 1964. 78p. Dep.(mn)

A total of 238 references is presented on experimental and theoretical aspects of accelerators and associated equipment. Author and report number indexes are included. (R.E.U.)

4771 (BNL-8528) A PROGRAM FOR PARTICLE BEAM OPTICS. Internal Report. E. J. Sacharidis (Brookhaven National Lab., Upton, N. Y.). Aug. 16, 1964. Contract AT(30-2)-Gen-16. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Given a definite beam set-up composed of a target, a set of free spaces, quadrupoles, bending magnets, and collimators (scintillators), the program computes the following features of the beam: momentum distribution and its half width; phase space $\int (d\,p\,dw/p_0)$ (p_0 = reference momentum and w = solid angle) at the target and at any position, if required; transfer matrices; cross section; horizontal angular distribution and its half width; and vertical angular distribution and its half width. All bending magnets bend the particle trajectories in the same plane, called horizontal, and one of the focusing or de-focusing planes of the quadrupoles is the horizontal one. The magnets may have skew boundaries and provision is made to read in precalculated matrices of beam elements other than those above as well as lower and upper limits of momentum, horizontal and vertical slope. The latter facility enables one, from the emittance of the beam at one place, to calculate its properties at subsequent places. (auth)

4772 (LA-DC-6539) EXPERIENCE WITH BACK-BIASED ACCELERATING TUBES. J. L. McKibben (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 22p. (CONF-795-3) Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Symposium on Insulation of High Voltage in Vacuum, Cambridge, Mass., Oct. 1964.

Operating experience for different back-biased ion accelerating tubes in the vertical Los Alamos electrostatic generator is reviewed for a 15 year period. (R.E.U.)

4773 (NP-14339) ACCELERADORES DE PARTICULA. (Particle Accelerators). R. Slobodrian (Buenos Aires. Universidad. Facultad de Ciencias Exactas, Fisicas y Naturales). July 1961. 50p.

The outline of the course presented at the Escuela Latinoamericano de Fisica in July 1961 is given. The characteristics of static accelerators, accelerators with magnetic field guides, accelerators with alternating gradient focusing, accelerators with alternating gradient and static guide fields, and isochronous cyclotrons are described. (J.S.R.)

4774 (SLAC-PUB-53) PULSED BENDING MAGNET SYSTEM FOR THE STANFORD TWO-MILE ACCELERATOR. J. L. Cole and J. J. Muray (Stanford Univ., Calif. Stanford Linear Accelerator Center). Oct. 1964. Contract AT(04-3)-400. 37p. (CONF-799-5). Dep.(mn); $2.00(cy), 1(mn) OTS.

From 11th Annual Nuclear Science Symposium, Philadelphia, Oct. 1964.

The electron beam from the Stanford two-mile linear accelerator is analyzed by a high-quality magnetic deflection system in the beam switchyard. The first magnet element in this system is a pulsed switching magnet capable of switching beams of different energies and intensities to either transport system on a pulse-to-pulse basis. This magnet actually consists of five one-meter sections and is powered by pulsed high-voltage supplies (modulators). Each magnet section is excited with two modulators because it must pulse in either polarity in order to switch the beam left or right; the pulse height should be continuously variable to accommodate any beam energy. The magnetic field in these magnets rises sinusoidally 360 times a second and has a peak value at 1700 gauss. The optical properties of pulsed magnets are discussed briefly. Detailed descriptions of the pulsed magnet modulators, the instrumentation for the magnet, and the test results are given. The problems connected with high-power switching at high repetition rates are discussed. (auth)

4775 (SLAC-PUB-57) PRECISION MAGNETIC MEASUREMENTS USED FOR THE DESIGN OF THE STANFORD TWO-MILE LINEAR ACCELERATOR TRANSPORT SYSTEMS. J. K. Cobb and J. J. Muray (Stanford Univ., Calif. Stanford Linear Accelerator Center). Oct. 1964. Contract [AT(04-3)-400]. 17p. (CONF-799-2). Dep.(mn); $1.00 (cy), 1(mn) OTS.

From 11th Annual Nuclear Science Symposium, Philadelphia, Oct. 1964.

In order to utilize the electron beam of the Stanford two-mile accelerator effectively, an elaborate beam switchyard will be used. Two basic components constitute the switchyard: a switching magnet and two deflecting transport systems. A precision deflection magnet system containing several d-c magnets and quadrupoles will bend and momentum-analyze the electron and positron beams. The methods and techniques used in making high-precision magnetic measurements in d-c and multipole magnetic fields are discussed. The requirements for the accuracy of field measurements are deduced from the beam optics of the transport systems. Special measurements and instruments used in these measurements are discussed in detail, and the results of these measurements are related to the optical properties of the particle beams. Special measurements in multipole magnets, such as the location of the magnetic center, the magnetic coordinate system, multipole content, effective length, and different methods of making such measurements, are discussed. (auth)

4776 (UJV-1093/64) MĚŘENÍ KONEČNÉ ENERGIE A CISTOTY URYCHLENÝCH ALFA-ČÁSTIC NA CYKLOTRONU ÚJV. (Measurements of the Finite Energy and Frequency of Accelerated Alpha Particles of the Cyclotron of the Univ. of Nuclear Research). T. Fukátko, J. Habanec, O. Karban, M. Karmasin, and K. Kult (Československá Akademie Věd. Ústav Jaderného Výzkumu, Řež.) [1963]. 12p. Dep.(mn).

The 120-cm cyclotron was used for accelerating alpha particles to a maximum energy of 26.3 Mev. The extracted beam intensity was 100 μamp. (R.V.J.)

4777 SPACE CHARGE LIMITS AND CYCLOTRON BEAM ENHANCEMENT. K. R. Mackenzie (Univ. of California, Los Angeles). Nucl. Instr. Methods, 31: 139-46 (Dec. 1, 1964).

It is shown that the ion density in the beam at small radii limits the output of cyclotrons, even f.m. cyclotrons. Space charge spreads the beam and causes a vertical loss which, in the case of slit and puller sources, can be as severe as the inverse fourth power of the radius. Correspondingly, the useful beam varies inversely as the fourth power of the effective radius where the ions first encounter large magnetic focusing forces. For open sources this dependence drops to the inverse square. For either type of source the useful internal beam is found to vary as the cube of the gain per turn. Synchrocyclotrons capture a small fraction of the space-charge-limited beam at small radii. Even though the f.m. rate must increase with voltage, it appears that the captured beam still varies as the cube of the gain per turn. Experimental confirmations are presented. Finally some suggestions are made for increasing the output of cyclotrons, especially f.m. cyclotrons. (auth)

4778 ENERGY SPECTRA OF STRAY NEUTRONS FROM BEVATRON. Richard L. Lehman and Olga M.

Fekula (Univ. of California, Berkeley). Nucleonics, 22: No. 11, 35-9(Nov. 1964).

Nuclear emulsions were used to determine the energy spectra of stray neutrons within a 260 m radius from the Bevatron center. The general form of the stray-neutron spectra is a broad peak in the 0.5 to 2 Mev region, followed by a smooth 100-fold drop in value between the peak and 12 Mev. (C.E.S.)

4779 MEASUREMENT AND CORRECTION OF THE FIELD INDEX VARIATION DURING THE BETATRON ACCELERATION CYCLE. S. Haltrich and I. Leibovici (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 253-62(1964).

The field index in a betatron changes at the beginning and the end of the acceleration cycle, at low and high magnetic fields, respectively, relative to the normal value for mean fields. The variations at high fields were measured using a circuit composed of a bridge and an integrator. Because the field index decreases near the target radius, the beam undergoes a vertical defocusing. At low fields, the field index was calculated using the radial phase differences of the magnetic field, which were measured with peaking strips. The resolution of the circuit was 10 nsec. The field index at injection was corrected by use of polar coils; an increase of 2 to 3 times in radiation intensity was obtained. (auth)

4780 THE STABILITY OF ELECTRON BEAM VIA THE PERIODIC FIELDS. Lin-shu Tung. Wu Li Hsueh Pao, 20: 761-76(Aug. 1964). (In Chinese)

The stability of an intense electron beam via the periodic static electric and magnetic fields is discussed. The stability and instability regions of a cylindrical electron beam through periodic harmonic electromagnetic field and periodic anharmonic fields in sawtooth, square, and trapezoid forms are given. Compared with the major instability regions of the various fields, the instability region of the sawtooth form is smaller than others. When space charge effect is appreciable, the electron beam in the stable region is conditionally rather than unconditionally stable. It is dependent on the intensity of the space-charge current and the amplitude of the electron beam. (auth)

4781 40-MEV LINEAR ELECTRON ACCELERATOR. V. M. Grizhko, V. A. Vishnyakov, I. A. Grishaev, E. V. Eremenko, G. F. Kuznetsov, E. K. Ostrovskii, and V. I. Khvorostenko. Zh. Tekhn. Fiz., 34: 1903-5(Oct. 1964). (In Russian)

Descriptions are given of a 40-Mev linear accelerator consisting of injector and accelerator sections with two high-frequency klystron amplifiers excited by one stabilized magnetron generator. The accelerator operates at 2797.2 Mc at +37°C; pulse duration, 1.5 μsec; and 50 pulses per second. At the accelerator exit the beam diameter is 4 to 6 mm at 6 μa mean current. The synchronization system enables operation at 50, 25, 12.5, or 6.3 pulses per second. The accelerator was designed for investigations of electron and γ interactions with nuclei and is capable of a smooth change of energy between 5 and 40 Mev. (R.V.J.)

4782 IMPROVEMENTS IN OR RELATING TO TARGETS FOR NEUTRON GENERATORS. Reuben Redstone and Michael Charles Rowland (to United Kingdom Atomic Energy Authority). British Patent 974,622. Nov. 11, 1964. Filed Aug. 30, 1960.

An accelerator target for neutron production is described. A thin layer of Y or other lanthanide, impregnated with hydrogen to a ratio of 1.7 to 1, is deposited on Mo, W, Cr, or Mn. The layer thickness is about 1.25 mg/cm^2 for beams of 100 kv. (T.R.H.)

Astrophysics and Cosmology

Refer also to abstracts 4869, 5076, and 5079.

4783 (FTD-TT-64-1077) COSMIC RESEARCH. Translation of Kosmicheskie Issledovaniya, 2: No. 5, 657-813(1964). 261p. OTS.

Separate abstracts were prepared for 6 of the 15 papers included; the remaining papers are concerned with satellite motion, celestial mechanics, astronaut training, and effects of impact g-forces on animal organisms. (R.E.U.)

For abstracts of individual papers see: 3898, 4746, 4863, 4864, 5054, and 5055.

4784 EXPERIMENTAL DATA BEARING ON QUESTIONS OF COSMIC DUST GENESIS AND TABULATIONS OF THE ABUNDANCES OF THE ELEMENTS. William A. Cassidy (Columbia Univ., Palisades, N. Y.). Ann. N. Y. Acad. Sci., 119: 17-40(Nov. 11, 1964).

Cosmic dust formation was studied by sealing known mixtures of Fe, FeO, MgO, and SiO_2 in silica-glass tubes under a moderate vacuum and maintaining the systems at controlled temperatures in vertical-tube furnaces from which the samples were dropped into Hg or H_2O after establishment of chemical equilibrium. The frozen-in chemical equilibrium was studied. The results are presented and extrapolated to higher temperatures. The condensation of cosmic dust is discussed in terms of the inferred phase relations, using a hypothetical model for the early solar system. (D.C.W.)

4785 THE ABUNDANCE OF MAGNESIUM IN THE ATMOSPHERES OF O AND B STARS. Richard C. Henry and Dimitri Mihalas (Princeton Univ., N. J.). Astrophys. J., 140: 873-84(Oct. 1, 1964).

Equivalent widths were computed for the ionized magnesium line λ 4481 using flux-constant models and accurate numerical techniques. Several abundance steps were taken for each model; the models have temperatures appropriate to stars in the range of 09 V to A2 V. Fits are made to the mean observed line strength as a function of spectral type as obtained from data in the literature. A nearly constant mean value of $N(Mg)/N(H) = 2.2 \times 10^{-4}$ is derived over the range of spectral types of B1 to A2; a larger value is obtained for B0 and O9 stars, but this is thought to be spurious. This analysis reaffirms the discrepancy between solar and B-star Mg abundance. (auth)

4786 A SPECTROSCOPIC ESTIMATE OF THE ATMOSPHERIC PROPERTIES OF O AND B STARS. Dimitri Mihalas (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 140: 885-901(Oct. 1, 1964).

Equivalent widths of lines in the spectra of six O stars were measured using the coudé scanner of the 100-inch telescope. These data and those in the literature for τ Sco are fitted to theoretical line-strength calculations in an attempt to derive the effective temperatures, gravities, and helium abundances of these stars. It is found that the effective temperatures and gravities are well determined, while the helium abundance can be estimated only with fair accuracy; it appears that the best estimate for N(He)/N(H) is about 0.15 or 0.2. Comparisons are made between the computed and observed profiles for λ 4686 in γ Sco and 10 Lac; a good fit with the 10 Lac observations can be obtained only with a turbulent velocity of the order of 20 km/sec. (auth)

4787 A STUDY OF THE VELOCITY FIELD IN M82 AND ITS BEARING ON EXPLOSIVE PHENOMENA IN THAT GALAXY. E. Margaret Burbidge, G. R. Burbidge, and Vera C. Rubin (Univ. of California, San Diego, La Jolla). Astrophys. J., 140: 942-68(Oct. 1, 1964).

A detailed spectroscopic study of M82 was carried out from spectra taken in nine different position angles, and extending about 2′ from the center of the galaxy (the radius of M82 is about 4′). In many position angles, the velocity-curves from the emission lines show steep gradients and large dips, when compared with the observed absorption-line rotation-curve obtained by Mayall, and confirm and give more information about the expansion stemming from an explosion as it was first discovered by Lynds and Sandage. It appears that the gas which was blown out forms a double cone with a half-angle ≈20°. The true space velocity is about 450 km/sec for the gas furthest from the center whose line-of-sight velocity can be measured. The

forms of the velocity-curves in position angles 0 and 145° (the position angle of the major axis of the galaxy is 62°) show that one is observing gas in the exploded cones above and below the main body of the galaxy and that these obey approximately linear velocity-distance relations, while the velocity-curve of the gas in the main body of the galaxy indicates that it has undergone damping and deceleration. It is estimated that the explosion that gave rise to the gas now seen in the exploded double cone took place between 2 and 3 million years ago. Study of the spectral features due to the stars in M82 suggests that there is a real difference in stellar population between the central part and the outer parts. A rediscussion of the energetics of the outburst is given. It is concluded that a total energy of $\sim 10^{57}$ erg or greater may have been released in the last few million years, a value considerably greater than the mimimum total energy obtained by Lynds and Sandage. This value was obtained because it is assumed that the optical synchrotron radiation is produced by electrons with radiation half lives that are short compared with the age of the primary explosion, so that many generations of electrons were produced. A similar situation is thought to apply to the Crab and the jet in M87, both of which are also sources of optical synchrotron radiation. (auth)

4788 THE RADIO STRUCTURE OF IC 443. David E. Hogg (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 140: 992-1001(Oct. 1, 1964).

Radio observations at three frequencies with high resolution were made of the supernova remnant IC 443. The spectral index is nearly constant throughout the nebula, with a mean value of −0.4. The maximum of the radio emission coincides with the strongest optical feature, supporting Minkowski's suggestion that the interaction between the expanding supernova shell and the interstellar medium enhances the radio emission. A model of the distribution of emissivity along a line through the center of the nebula was determined; in the east, where the optical radiation is strongest, the radio emission is confined to a narrow shell, while in the west the emission is more uniformly distributed, and no shell is found. Finally, the total energy of relativistic particles within IC 443 is discussed. (auth)

4789 FREE-FREE EMISSION BY INTERGALACTIC HYDROGEN. George B. Field and Richard C. Henry (Princeton Univ., N. J.). Astrophys. J., 140: 1002-12 (Oct. 1, 1964).

The amount of free-free emission by intergalactic hydrogen is calculated and compared with observation. The calculations are carried out for the steady-state model and for closed evolving models with $q_0 = \frac{1}{2}$ and 1. It is shown that the temperature of the intergalactic medium must be less than 4×10^6°K (steady-state model) or 3×10^6°K ($q_0 = \frac{1}{2}$ or 1), judging by recent x-ray results. A simple analytic expression is derived for the emission in a steady-state model, which is finite for all assumed values of the temperature. The emission in evolving models depends critically on the behavior of temperature with density at distant points; for effective ratios of specific heat between $\frac{4}{3}$ and 2, the results indicate unbounded intensities at the earth. Calculations of the intensities emitted by material out to limited values of the redshift indicate that future observations, particularly just shortward of 20 Å, may provide decisive information on the state of the universe at earlier times. (auth)

4790 PLASMA NEUTRINO EMISSION FROM A HOT, DENSE ELECTRON GAS. Cullen L. Inman (New York Univ., New York and Goddard Inst. for Space Studies, New York) and Malvin A. Ruderman. Astrophys. J., 140: 1025-40 (Oct. 1, 1964).

Neutrino pair emission from coherent electron excitations (transverse plasmons) in a hot, dense stellar plasma is calculated for a regime of temperatures and densities relevant to stellar evolution. Detailed numerical results are presented for temperatures in the range $4 \times 10^7 - 5 \times 10^{10}$°K and densities in the range $10^4 - 10^8$ gm/cm^3. (auth)

4791 STRUCTURE AND EVOLUTION OF MEDIUM-MASS STARS. I. MAIN-SEQUENCE MODEL OF 2.5 SOLAR MASSES. J. Bahng (Northwestern Univ., Evanston, Ill.). Astrophys. J., 140: 1041-4(Oct. 1, 1964).

The initial main-sequence model of a star of 2.5 solar masses was constructed with the following refinements: New interpolation formulas for the nuclear-energy generation were derived: one for the p-p reaction, another for the C-N reaction. Both formulas were used together in computing the energy-generation rate, thereby taking into account the contributions of both reactions to the luminosity of the star. The energy generation in the radiative zone outside the inner convective core was included. In this model approximately 6 per cent of the total luminosity is due to the energy produced in the radiative envelope. The over-all structure differs very little from that of a model computed on the assumption that the total luminosity of the star is entirely due to the energy generation confined completely within the convective core. The non-negligible energy production, and therefore subsequent composition changes in the outer radiative zone, may, however, have an appreciable influence on the structure of a star in the evolved stages. (auth)

4792 ON THE BEHAVIOR OF RADIATION NEAR MASSIVE BODIES. J. Faulkner, F. Hoyle, and J. V. Narlikar (Cambridge Univ., Eng. and California Inst. of Tech., Pasadena). Astrophys. J., 140: 1100-5(Oct. 1, 1964).

The problem of communication between an observer on the surface of a massive body and an external Schwarzschild observer is examined. It is shown that when the body is freely imploding, a signal from the external observer never reaches the surface provided the Schwarzschild coordinate of the external observer exceeds a critical value depending on the mass and radius of the body. The signals that reach the surface are redshifted. Time reversal of the solution then shows that radiation from an exploding massive body will be blueshifted when it reaches an external observer. This effect may supply the explanation for the origin of high-energy particles and quanta. (auth)

4793 VELOCITY FIELDS IN THE SOLAR ATMOSPHERE. III. LARGE-SCALE MOTIONS, THE CHROMOSPHERIC NETWORK, AND MAGNETIC FIELDS. G. W. Simon and R. B. Leighton (California Inst. of Tech., Pasadena). Astrophys. J., 140: 1120-47(Oct. 1, 1964).

Results of a detailed study of large-scale cellular motions in the solar photosphere are presented. The velocity cells (called supergranules) are of various sizes and shapes and have an average diameter of 32000 km and a 20-hour lifetime; the motion within each cell is mainly horizontal, proceeding from the center toward the outer boundary with a velocity of 0.3−0.5 km/sec. A strong spatial correspondence is found between the cell boundaries and several other features: the chromospheric Ca^+ λ 3934 network; the network of descending matter (1.0−2.0 km/sec) observed in Hα and Hβ; and the magnetic field pattern. The characteristics of the velocity cells suggest that they are non-stationary convection currents originating perhaps at a quite deep level inside the convective envelope. These observations, together with the theoretical predictions of Parker and Osterbrock, suggest an explanation for the origin of the chromospheric network seen in Ca^+ and in the Balmer lines. (auth)

4794 ON THE EMPIRICAL TEMPERATURE STRUCTURE OF THE SOLAR CHROMOSPHERE. O. R. White (Sacramento Peak Observatory, AFCRL, Sunspot, N. Mex.). Astrophys. J., 140: 1164-9(Oct. 1, 1964).

A new analysis of the Balmer-line limb-darkening observations gives maximum excitation-temperature differences of 165°K between Hα and Hβ. This new analysis allows for gradients in both the excitation temperature and the Doppler width, and reproduces the observed limb darkening at wavelengths out to 0.3 Å in Hα. (auth)

4795 TIME-DEPENDENT CORONAL IONIZATION. L. L. House and D. E. Billings (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 140: 1182-91(Oct. 1, 1964).

Time-dependent ionization processes are tested for possible significance under the conditions of a shock wave passing through the corona. Equations are solved to de-

termine the time variation of ion and electron temperatures. The resulting electron temperature is used to compute the time variation in ionization of iron. The results of these calculations, when compared to observational characteristics of the corona, definitely favor processes in the corona comparable in scale and frequency to those in the photosphere. (auth)

4796 THE ORIGIN OF CORONAL EMISSION LINES. M. H. L. Pryce (Univ. of Bristol, Eng.). Astrophys. J., 140: 1192-1205(Oct. 1, 1964).

The emission spectra of ions with 4–20 electrons are surveyed with a view to extending the identification of coronal lines. In particular, it is suggested that ions with 4, 10, 18, or 20 electrons might be responsible for coronal lines. In another paper, Collins shows that λ 5926 could reasonably be ascribed to the 4-electron spectrum Ar XV. It is suggested that Ni IX, Cu X, and Zn XI contribute lines to the coronal spectrum. (auth)

4797 RELATIVISTIC CALCULATIONS OF THE Z-DEPENDENCE OF ATOMIC-ENERGY LEVELS WITH APPLICATION TO THE IDENTIFICATION OF SOME CORONAL EMISSION LINES. P. D. B. Collins (Univ. of Bristol, Eng.). Astrophys. J., 140: 1206-15(Oct. 1, 1964).

The methods of D. Layzer for calculating the Z-dependence of atomic energy levels are applied to the calculation of the first and second relativistic corrections to first-order perturbation theory, for configurations containing two, three, and four electrons. The results for the separations $1s^2\ 2p\ ^2P_{\frac{3}{2}}-{}^2P_{\frac{1}{2}}$, and $1s^2\ 2s\ 2p\ ^3P_2-{}^3P_1$ and $^3P_2-{}^3P_0$ are compared with experiment, and empirical coefficients for higher orders of perturbation derived, which enable an improvement and extension of the experimental data. The coronal line λ 5926 is identified with $^3P_2 \rightarrow {}^3P_1$ in Ar XV, and an explanation offered for the absence of the corresponding lines of K XVI and Ca XVII. (auth)

4798 THE LIMB FLARE OF NOVEMBER 20, 1960. A CORONAL PHENOMENON. Harold Zirin (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 140: 1216-35 (Oct. 1, 1964).

Observations of the explosive limb flare, which produced a moderate ground-level cosmic-ray event, are presented. The explosive phase is shown to coincide with the beginning of radio and x-ray emission. The fact that the flare occurred over the limb shows that such emission comes from above 30000 km in the corona. This emission is even observed at stages when no Hα is seen. Spectra of the flare show it to be a coronal phenomenon, particularly after the energy release in the explosive phase. The total number of electrons in the line of sight is measured directly from the continuum radiation, and an electron density of 10^{11} per cm^3 is inferred from symmetry. The ratio of the two coronal lines of Ca XV is discussed and compared with theoretical calculations as another method of density determination. The mean ratio 5694/5445 is observed to be 1.5. From the ratio of coronal-line intensity to continuum radiation, it is possible to deduce approximate abundances, and the abundance of calcium is found to be considerably less (10 times) than that of iron in the corona. Study of the ratios of three ionized helium lines shows that the spectrum of ionized helium is due to pure recombination. The Lyman-α resonance mechanism is shown to be non-existent or unimportant since the Lyman radiation could only excite He II levels with n even, whereas lines originating on n odd are anomalously strong. The helium emission is compared with the distribution of coronal and continuum radiation, it is found that most of the material in the flare is at coronal temperatures. The kinetic energy still present in the coronal condensation two hours after the explosion was 10^{30} erg. It is conceivable that a substantial fraction of the condensation may be at temperatures >4,000,000°K. (auth)

4799 SOLAR FLARES WITH ASSOCIATED ACTIVE DARK FILAMENTS AND THEIR RELATION TO 2800-Mc/s RADIO BURSTS. Marion W. Haurwitz (National Bureau of Standards, Boulder, Colo.). Astrophys. J., 140: 1236-46 (Oct. 1, 1964).

Preliminary examination indicates that those solar flares that have associated dark filament activations are highly productive of 2800-M radio bursts. The study determines statistically the strength of this relation; independently of other optical-flare characteristics, active dark filaments are related to the radio bursts at a very high level of significance. This statistical relation is interpreted physically in terms of a strong interaction between a shock wave, or other disturbance propagating from the flare, and a magnetic field of the filament. This interaction, observed as the dark filament activation, accelerates electrons contained in the filament to energies adequate for the production of high-frequency synchrotron emission. It is concluded that the radio emission will not be generated unless the outburst of flare energy interacts with a strong magnetic field, loop-like in form, such as suggested by the filament structure. The statistical methods used, which handle mixed discrete and continuous variables, are described in considerable detail. (auth)

4800 THE ISOTOPE RATIO C^{12}/C^{13} IN A COMET. Antoni Stawikowski and Jesse L. Greenstein (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 140: 1280-91(Oct. 1, 1964).

High-resolution spectra of Comet Ikeya (1963a) show the $^{12}C^{13}C(1,0)$ band at λ 4745 with measurable strength. Its intensity was measured and compared with the intensity of two unresolved-triplet, rotational lines of $^{12}C^{12}C(1,0)$. The structure of the isotope band was computed to obtain the number of lines forming the observed head. From the theory of the excitation of comet lines by resonance fluorescence, the isotope ratio $^{12}C/^{13}C$ is found to be 70 ± 15. Solar-absorption features, although included, modify the excitation pattern of the C_2 lines only slightly, unlike the CN band which has strongly deficient solar radiation. A feature at λ 4752 appears near $^{13}C^{13}C(1,0)$. Its strength is too great to be compatible with $^{12}C/^{13}C \approx 70$, requiring an unacceptably low value. A discussion as to whether $^{12}C^{13}C$ can be de-excited by pure rotation, unlike the homonuclear ^{12}C molecules, leads to no definite conclusion since the dipole moment of $^{12}C^{13}C$ is unknown. It is believed that λ 4752 is largely affected by a blend with NH_2. Another slight blend, at λ 4745, may require a slightly higher isotope ratio $^{12}C/^{13}C$. The $^{12}C/^{13}C$ ratio is near that on the earth. Some implications for the early history of the solar system are drawn. If the solar $^{12}C/^{13}C$ ratio proves indeed to be very high the cometary ^{13}C could have been produced by neutron irradiation. (auth)

4801 X-RAYS AND TYPE I SUPERNOVA REMNANTS. L. Woltjer (Columbia Univ., New York). Astrophys. J., 140: 1309-13(Oct. 1, 1964).

The properties of Type I supernova remnants are briefly reviewed, and a possible explanation for the x-ray emission associated with them is discussed. (C.E.S.)

4802 LITHIUM IN CARBON STARS. Silva Torres-Peimbert, George Wallerstein, and John G. Phillips (Univ. of California, Berkeley). Astrophys. J., 140: 1313-17 (Oct. 1, 1964).

The ratio of lithium to calcium in seven carbon stars is estimated by a comparison of the lithium line at λ 6707 with the intercombination line of calcium at λ 6572. Equivalent widths of the two features were measured by connecting high points in the spectrophotometric tracings to form a pseudocontinuum. Possible explanations for the high lithium content in carbon stars are considered. (C.E.S.)

4803 "EFFECTS OF NON-CONSTANT SCATTERING OPACITY ON MODELS FOR MASSIVE STARS INITIALLY COMPOSED OF PURE HYDROGEN. A. Boury (California Inst. of Tech., Pasadena). Astrophys., J., 140: 1322-6 (Oct. 1, 1964).

The effect of a small variation in electron-scattering opacity on the properties of massive stars originally composed of pure hydrogen was investigated and found to be not negligible. (C.E.S.)

4804 A NEW MEASUREMENT OF THE CHROMOSPHERIC EMISSION LINE λ 10830. Richard Royal Fisher (Univ. of Colorado, Boulder and High Altitude Observatory, Boulder, Colo.). Astrophys. J., 140: 1326-8(Oct. 1, 1964).

Spectra were made of the chromosphere and corona in the wavelength region of the Fe XIII lines of λ 10747 and λ 10798. Several distinct emission features at λ 10830 also showed up on the plates. The λ 10830 chromospheric emission-line profiles are illustrated, and the parameters of these profiles are tabulated. (C.E.S.)

4805 A NEW MODEL OF SOLAR FLARES. P. A. Sturrock and B. Coppi (Stanford Univ., Calif.). Nature, 204: 61-2(Oct. 3, 1964).

A model in which the energy of solar flares is accumulated as gravitational potential energy, as gases condense in the solar atmosphere, is proposed. The atmospheric circulation patterns resulting from this model are described. Particular attention is given to the explanation of the flash phase of the flares by means of the model. (T.F.H.)

4806 SPECTRUM AND RELATIVE INTENSITIES OF INTERSTELLAR OH LINES. A. H. Barrett and A. E. E. Rogers (Massachusetts Inst. of Tech., Cambridge). Nature, 204: 62-3(Oct. 3, 1964).

The line frequencies, theoretical relative intensities, and transition probabilities for various transitions in isotopic species of OH (^{16}OH, ^{16}OD, and ^{18}OH) in the range 310 to 6050 Gc, for lines that should be detectable in interstellar space, are given. (T.F.H.)

4807 INVERSE COMPTON EFFECT AS A POSSIBLE CAUSE OF THE X-RAY RADIATION OF SOLAR FLARES. Loren W. Acton (Lockheed Missiles and Space Co., Palo Alto, Calif.). Nature, 204: 64-5(Oct. 3, 1964).

It is hypothesized that the inverse Compton effect has a negligible effect on the x radiation emitted during solar flares, because the cloud of relativistic electrons required to produce the observed x-ray intensity by this mechanism would generate a far greater amount of bremsstrahlung than has been observed during flares. (T.F.H.)

4808 CONSERVATION OF PROTONS IN A STABLE NICKEL NUCLEUS. R. Brandt (CERN, Geneva). Nature, 204: 271(Oct. 17, 1964).

An attempt is made to detect the continuous production of protons in the cosmos, as predicted by various cosmological theories. The attempt is made by trying to detect the annihilation quanta from positron decay of ^{61}Cu, which would be produced if a proton were created in or near a ^{60}Ni nucleus. No radiation above background is detected. The half life for the ^{60}Ni → ^{61}Cu reaction is set at greater than 6×10^{18} yr. It is noted that this result apparently shows the proton production to be much lower than predicted by theory, but that various mechanisms may mitigate the discrepancy. (T.F.H.)

4809 ELECTRON OVERTAKING AS A CAUSE OF INSTABILITY AND TYPE III SOLAR RADIO BURSTS. D. E. Baldwin (Stanford Univ., Calif.). Phys. Letters, 12: 202-3 (Oct. 1, 1964).

A mechanism is suggested whereby a time-dependent source of electrons in an otherwise uniform stable plasma may give rise to electrostatic instabilities, even though no beam is generated by the source. The application of this mechanism to explain type III solar bursts and their association with solar flares is discussed. (T.F.H.)

4810 BARYON CONSERVATION IN SUPERDENSE STARS. K. Just (Argonne National Laboratory, Ill.). Phys. Letters, 13: 219(Dec. 1, 1964).

It was previously stated that baryons are destroyed under extreme pressures because no stable model is known for a star at vanishing temperature. By means of several assumptions, it is shown that models having several times the mass of the sun are possible. (C.E.S.)

4811 A NEW HYPOTHESIS TO ACCOUNT FOR THE RED-SHIFT IN THE SPECTRA OF DISTANT STARS. R. Fuerth (Leas Green, Chislehurst, Kent, Eng.). Phys. Letters, 13: 221-3(Dec. 1, 1964).

The fact that the lines in the spectra of distant stars show a red-shift proportional to their distances from the observer is usually interpreted as a Doppler effect. But from the point of view of the photon theory of light the observed red-shift could also be explained by the assumption that a photon travelling through space continually loses energy at a constant rate. A mechanism for the loss of energy of the photons is proposed which assumes only gravitational effects on photons and leads to a numerical value for the expected red-shift of the right order of magnitude. It also explains the anomaly in the red-shift of the spectral lines of the sun. (C.E.S.)

4812 EXPERIMENTAL LIMITS ON A POSSIBLE NEUTRINO DEGENERACY IN THE UNIVERSE. R. Cowsik, Y. Pal, and S. N. Tandon (Tata Inst. of Fundamental Research, Bombay). Phys. Letters, 13: 265-7(Dec. 1, 1964).

The question was previously raised whether the universe could be filled with a degenerate sea of neutrinos up to a certain Fermi energy E_F, without these neutrinos being detected in any experiments one can make. An upper limit of 100 ev was placed on the value of E_F for electron-antineutrinos and 500 ev for electron-neutrinos. For the muon-neutrinos the upper limit is a few Mev. Cosmic ray evidence is used to show that E_F is less than 2 ev for all types of neutrinos. (C.E.S.)

4813 INTERACTION BETWEEN THE SOLAR WIND AND THE LUNAR ATMOSPHERE. F. C. Michel (Rice Univ., Houston, Tex.). Planetary Space Sci., 12: 1075-91 (Nov. 1964).

The flow of the solar wind plasma about the Moon is studied in two limiting cases. Attenuation of the lunar atmosphere is found to be controlled by either flow pattern, while accretion from the solar wind can be important only under rather restrictive conditions. The expected composition and mass of the lunar atmosphere are discussed. (auth)

4814 MEASUREMENTS OF THE SOLAR SPECTRUM IN THE WAVELENGTH BAND 4 TO 14 Å. P. J. Bowen (London Univ.), K. Norman, K. A. Pounds, P. W. Sanford, and A. P. Willmore. Proc. Roy. Soc. (London), Ser. A, 281: 538-52(Oct. 6, 1964).

Over 150 low-resolution x-ray spectra obtained during the first 3-week period of satellite Ariel were reduced. These measurements illustrate the variations of the short-wavelength 'tail' of the solar x-ray spectrum in both intensity and spectral slope, under non-flare and flare-active conditions. Typical non-flare and flare-enhanced spectra are given. It is shown that the difficulty in describing the measured intensity of non-flare x-rays in this short-wavelength band, by the emission from a thermalized coronal plasma, may be removed by consideration of both line and continuum radiations from one or more discrete hot regions in the corona. An electron temperature of 5 million degrees is consistent with the non-flare emission spectrum typical of April 26–27, 1962. The x-ray enhancement associated with some chromospheric flares may also be interpreted as the thermal emission of a localized hot region, though the variability in the x-ray emission from one flare to another is quite marked. Three flares are described in detail; and of these, two appear to be of this 'simple,' thermal type. In the third flare an unusually rapid enhancement or x-ray 'burst' occurs about 20 min after the flare commencement. The spectral and time development of this 'burst' are described, and the excellent correlation with an impulsive microwave 'burst' and with the onset of the ionospheric effects are noted. The possibility of both microwave and x-ray bursts having a non-thermal origin is discussed. (auth)

4815 THE C-FIELD AS A DIRECT PARTICLE FIELD. F. Hoyle (St. John's Coll., Cambridge, Eng.) and J. V. Narlikar. Proc. Roy. Soc. (London), Ser. A, 282: 178-83 (Nov. 3, 1964).

It has been known for some years that a C-field, generated by a certain source equation, leads to interesting changes in the cosmological solutions of Einstein's equations. The steady-state cosmology appears as an asymptotic case. The source equation has so far only been given in the macroscopic case of a smooth fluid. The source

equation is derived in terms of discrete particles. The method adopted is similar to that recently given for the generalization to Riemannian space of the Fokker action principle in the electromagnetic theory. In the latter, a 4-vector is defined in terms of the world lines of particles. The definition is such that the four-dimensional curl of the vector satisfies Maxwell's equations, which are therefore identities. Similarly, C is a scalar defined in terms of the world-lines of particles, and the source equation used formerly then follows as an identity. (auth)

4816 MODEL-UNIVERSES IN HOYLE'S COSMOLOGY. Hidekazu Nariai (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 32: 450-64(Sept. 1964).

A systematic study of the permissible model-universes and their physical properties of Hoyle-Narlikar's cosmological equations is carried out by comparing them with those in the relativistic cosmology. It is revealed then that the models can be classified into three different types (A_1), (A_2), and (B). The type (A_1) consists of the steady-state model and the two steady-state-like models, which correspond to the three alternative Robertson-Walker metrics for the de Sitter empty space-time. The type (A_2) is characterized by the fact that, except for the matter density, the temporal behaviors of Hubble's expansion parameter and the deceleration parameter can be identified with those in the relativistic pressure-free models with a positive cosmic constant. Any model of the type (B) satisfies the conservation of total mass, just like the relativistic pressure-free models, and is very similar to the case of vanishing cosmic constant, but free from the initial singular event characteristic of the latter case. The problem of comparison with observational data concerning the redshift-magnitude relation and the time-scale criterion is also touched upon briefly. (auth)

4817 THE RELATION BETWEEN THE SPECTRUM OF SLOWLY VARYING COMPONENT OF SOLAR RADIO EMISSION AND SOLAR PROTON EVENT. Haruo Tanaka and Takakiyo Kakinuma (Nagoya Univ., Toyokawa, Japan). Rept. Ionosphere Space Res. Japan, 18: 32-44(1964).

The relation between the spectra of S component of the solar active regions and the solar proton events observed during May 1959–Dec. 1961 was investigated using the interferometric observations at 7.5 and 3.2 cm wavelengths. It was found that most of the solar proton bursts observed during this period occurred in the active regions that have the 3.2 to 7.5 cm flux density ratio of S component greater than one. The large flux ratio may be considered to indicate the existence of a good accelerator in the active region or the existence of a suitable condition for making a good accelerator at the time of flare. The high probability of occurrence of the solar proton burst in the active region with large flux ratio may be useful for the prediction of the solar proton event. (auth)

4818 ON THE PROBABILITY OF ASSOCIATION OF SWF WITH A SOLAR FLARE. Shigeo Hamana, Masahide Fukatsu, and Shingo Nagasawa (Tokyo Univ.). Rept. Ionosphere Space Res., Japan, 18: 92-6(1964).

It is shown statistically that the probability of association of SWF (Short Wave Fadeout) with a flare depends not only on the importance of the flare, but also on the activity, measured in a certain way, of C. A. (Center of Activity) in which the flare occurs. (auth)

4819 LUNAR OCCULTATION OF X-RAY EMISSION FROM THE CRAB NEBULA. S. Bowyer, E. T. Byram, T. A. Chubb, and H. Friedman (Naval Research Lab., Washington, D. C.). Science, 146: 912-17(Nov. 13, 1964).

The x-ray flux from the Crab Nebula was observed during a lunar occultation on July 7, 1964. As the moon covered the central region of the nebula, the x-ray flux decreased gradually. The source appears to extend over a volume about 1 light-year in diameter. (auth)

4820 QUASI-STATIONARY EMISSION OF GASES FROM THE SUN. E. Mustel (Astronomical Council, Academy of Sciences, Moscow). Space Sci. Rev., 3: 139-231 (Aug. 1964).

Experimental information on emission of gases by the sun is reviewed, together with associated theoretical considerations. The continuous emission of gases from undisturbed solar regions is considered, as well as the quasi-stationary emission from active regions. The possible flow of gases along the coronal rays above quiescent prominences-filaments is also discussed. 165 references. (D.C.W.)

4821 ON THE POSSIBILITY OF EXISTENCE OF REGIONS WITH ELEVATED NEUTRINO DENSITY. I. L. Lapides. Zh. Eksperim. i Teor. Fiz., 47: 964-5(Sept. 1964). (In Russian)

It is shown that the focusing action of gravitational fields of astrophysical objects may produce intense neutrino fluxes. (auth)

4822 ON GRAVITATIONAL COLLAPSE OF MAGNETIC STARS. V. L. Ginzburg and L. M. Ozernoi (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1030-40(Sept. 1964). (In Russian)

Gravitational collapse of a spherically symmetric mass of gas (star) possessing a magnetic dipole moment is considered. The high conductivity of the medium resulting in conservation of the magnetic field flux through a material contour is taken into account. Some problems are discussed which may be related to the magnetic field in case the collapse mechanism is invoked for explaining the observed phenomena (radio-galaxies and super-stars). (auth)

4823 IONOSPHERIC IONIZATION PRODUCED BY SOLAR FLARES AS MEASURED BY CONTINUOUS RECORDINGS OF f_{min}. COMPARISON BETWEEN PULSE AND MULTIFREQUENCY RIOMETER TECHNIQUES. Michael Anastassiades, D. Ilias, and P. Giouleas (National Observatory, Athens). p.47-52 of "Arctic Communications." Oxford, Pergamon Press, 1964.

The results of f_{min} and riometer observations are compared, and the possibility of studying the medium between the Earth and sun by multifrequency riometer observations is investigated. (D.C.W.)

Atomic Physics

Refer also to abstract 4932.

4824 (AD-607071) AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF RADIATION ON THE PROPAGATION OF ELECTROMAGNETIC SIGNALS IN AIR. Annual Technical Report. M. N. Hirsh, P. N. Eisner, and J. A. Slevin (Dewey (G. C.) Corp., New York). June 30, 1964. Contract DA-36-039-AMC-03278(E). 94p. (R-173-4) $4.00 (OTS).

Steady-state and afterglow measurements of electron densities have been made in O_2-N_2 mixtures weakly ionized by a spatially uniform flux of 1.5 Mev electrons from a Van de Graaff accelerator. The plasma is contained in a large uhf resonant cavity to which mass and optical spectrometers are appended; electron densities are deduced from measured shifts in the resonant frequency of the cavity. The large cavity size minimizes wall effects, and ultrahigh vacuum techniques safeguard gas purity. Measurements made over the range 0.8 to 10 torr indicate that the predominant linear electron loss process is three-body attachment to O_2, with the coefficient $\beta\ N^2 = (2.1 \pm 0.4) \times 10^{-30}\ N^2\ sec^{-1}$, where N is the number density of neutral O_2 molecules. The efficiency of N_2 relative to O_2 in stabilizing the attachment is found to be $\xi = 0.06 \pm 0.03$. Mass and optical spectroscopic measurements have been performed on the plasmas generated by the equipment described above. The principal positive ion found in N_2-O_2 mixtures in the pressure range 1 to 10 torr is O_2^+ for mixtures at least $1/3$ O_2; greater concentrations of N_2 shift the predominant ion to N_4^+ in this pressure range. The general features of the positive ion spectra for various experimental conditions are tabulated. Optical measurements show the First Negative System of N_2^+ to be directly excited by fast electrons from ground state neutral molecules. Cross sections for the ra-

diationless quenching of the $B^2\Sigma_u^+$ state by collisions with N_2 and O_2 are found to be 1.2×10^{-14} and 4×10^{-14} cm^2, respectively. Evidence for the origin of the Second Positive System in positive ion-electron recombination is presented. (auth)

4825 (CEA-R-2544) VARIATION DES ELEMENTS DE MATRICE DU DIPOLE DE L'ATOME H SOUS L'INFLUENCE D'UN CHAMP ELECTRIQUE EXTERIEUR UNIFORME. (Variation of the Matrix Elements of the Hydrogen Atom Dipole Under the Influence of a Uniform External Electric Field). Nguyen-Hoe, Eva Benerjea, Hans-Werner Drawin, and Louis Herman (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Aug. 1964. 37p. (EUR-1891.f). Dep.(mn).

The quantum mechanical perturbation theory as used in a foregoing paper, for the determination of the frequencies of the Stark components of hydrogen in a uniform external electric field, is used to calculate the intensities of the line components. The numerical results show that the influence of the perturbing electric field is important also in higher orders. (auth)

4826 (MATT-286) FINE STRUCTURE OF H_α AND H_β IN STRONG MAGNETIC FIELDS. P. C. Norem (Princeton Univ., N. J. Plasma Physics Lab.). June 1964. Contract AT(30-1)-1238. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The magnetic fine structure of the lines H_α and H_β of neutral hydrogen was determined for statistical population of the n = 4 and n = 3 levels. The results for both lines indicate a rapid approach to the Pashen Back limit. The lines are narrow and sharp, typically 0.05 Å wide in the higher field cases for a single polarization. The results are expressed as percentages of the total light intensity of each transition. All wavelengths given are the vacuum values. (auth)

4827 (TID-7705(p.163-74)) STACKING FAULTS IN B.C.C. CRYSTALS AND THEIR CONTRIBUTION TO DIFFRACTION LINE WIDTH. Aharan Ben Haim (International Atomic Energy Agency, Vienna).

Stacking faults occurring in b.c.c. crystals are described, and their effect on broadening of diffraction lines is analyzed. (R.E.U.)

4828 (TID-7705(p.194-213)) DIFFRACTION PATTERN—THEORIQUE D'UN CRISTAL COURBE ELASTIQUEMENT (CAS DE LA TRANSMISSION). (Theoretical Diffraction Pattern of an Elastic Curved Crystal (Case of its Transmission)). J. Despujols (Paris. Université, Reims. Faculte des Sciences).

The propagation of x rays in an elastically curved crystal with deformation was studied. Absorption is considered. (R.E.U.)

4829 (TID-21325) A VARIATIONAL CALCULATION OF THE GALVANO-MAGNETIC TRANSPORT COEFFICIENTS OF NONDEGENERATE SEMICONDUCTORS WITH OPTICAL MODE SCATTERING (thesis). Technical Report No. 31. Shaun S. Devlin (Case Inst. of Tech., Cleveland). Feb. 1964. Contract AT(11-1)-623. 72p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The application of several variational principles to the solution of the Boltzmann equation is discussed. The principle outlined by Seeger is developed in detail to calculate all the low-field transport properties and is applied to the calculation of the galvanomagnetic transport coefficients, including the Nernst coefficient and the Lorentz number, ir partially ionic nondegenerate semiconductors with optical mode scattering. The results are compared with other theoretical work and experiment. (auth)

4830 AVERAGE ENERGY, AVERAGE VELOCITY AND MEAN FREE PATH OF SLOW ELECTRONS IN HELIUM AND ARGON. O. J. Orient (Polytechnical Univ., Budapest). Acta Phys. Acad. Sci. Hung., 17: 387-93 (1964).

The average energy, average velocity, and mean free path of slow electrons in Ar and He were determined for four values of the electric field strength, using the electron energy distribution function derived by Barbiere for the two gases and four field strengths. (D.C.W.)

4831 CALCULATION OF THE ORDER OF MAGNITUDE OF MULTIPHOTON PROCESSES. Pierre Nelson (CEA, Paris). Compt. Rend., 259: 2185-6(Oct. 5, 1964). (In French)

The Feynman diagram technique, made usable by a simple approximation, permits the introduction of a critical illumination I_0, beyond which the multiphoton phenomena become preponderant. For the wave length of the ruby, $I_0 = 5 \times 10^9$ w/cm^2. (tr-auth)

4832 SECONDARY ELECTRON EMISSION OF CADMIUM SULFIDE. Pierre Pinard, Jean-Paul Paris, and Guy Matteudi (Institut National des Sciences Appliquees, Lyon). Compt. Rend., 259: 2187-9(Oct. 5, 1964). (In French)

The observation of vaporized layers and monocrystals of cadmium sulfide on the sweep microscope showed the evolution of secondary electron emission under irradiation. This effect was measured and an attempt was made at interpretation. (tr-auth)

4833 EMISSION SPECTRA OF He–Ne. Janine Fache (Institut de Physique, Lille, France and Max-Planck-Gesellschaft, Gottingen, Ger.). Compt. Rend., 259: 2195-7(Oct. 5, 1964). (In French)

Four bands that seem attributable to the $He-Ne^+$ ion were observed near 4238 Å. The corresponding bands were observed with the mixture of neon and helium-3. (tr-auth)

4834 FORBIDDEN TRANSITIONS IN THE L-SPECTRUM OF THORIUM. B. D. Padalia and G. B. Deodhar (Univ. of Allahabad, India). Indian J. Pure Appl. Phys., 2: 287-9(Sept. 1964).

A detailed study of the forbidden transitions of the L-spectrum of thorium was made, using a 40-cm curved mica crystal spectrograph. Analysis of the spectrum established the existence of a nonquadrupole L_IM_I transition in the L-spectrum of thorium. The existence of lines corresponding to the forbidden transitions $L_{II}M_{II}$, $L_{II}N_{III}$ and $L_{III}N_{III}$ reported by Cauchois was also confirmed. No trace of the lines corresponding to the nonquadrupole transition $L_{II}N_{II}$ and the forbidden transition $L_{II}N_V$ was obtained. (auth)

4835 ABSOLUTE PHOTOELECTRIC CROSS-SECTIONS OF 662 kev GAMMA RAYS. K. Parthasaradhi, V. Lakshiminarayana, and Swami Jnanananda (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 2: 290-2(Sept. 1964).

Absolute photoelectric cross sections of 662-kev, gamma rays were determined experimentally in lead, platinum, tantalum, tin and silver, using a well-type plastic crystal scintillation spectrometer. The experimental values obtained were compared with the theoretical values computed from the expressions given by Nagel and Sauter as well as with the interpolated values from the NBS Circular 583. The agreement with the NBS Circular values is within the range of experimental error. (auth)

4836 ABSOLUTE PHOTOELECTRIC CROSS-SECTIONS OF 145 kev GAMMA RAYS. K. Parthasaradhi, V. Lakshminarayana, and Swami Jnanananda (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 2: 306(Sept. 1964).

The absolute photoelectric cross sections of 145-kev, gamma rays in copper, silver and tin were experimentally determined using a well-type plastic crystal scintillation spectrometer. The values obtained are 10.5 ± 0.8, 80 ± 6 and 102 ± 8 b per atom in copper, silver and tin, respectively. These values were compared with the values computed from the expressions of Heitler-Stobbe, Sauter, Sauter-Stobbe and Nagel, as well as with the NBS interpolated values. It was found that the agreement between the present values and the NBS values is better than that with the values computed from the other theoretical expressions. (auth)

4837 LOW-ENERGY SPUTTERING YIELDS BY RESONANCE ABSORPTION AND EMISSION SPECTROSCOPIC METHODS. W. C. Kreye (Electronic Research Branch, Wright-Patterson AFB, Ohio). J. Appl. Phys., 35: 3575-82(Dec. 1964).

Low-energy sputtering yields for a (110)-oriented gold single crystal are determined by means of a resonance or atomic absorption technique wherein the sputtered atoms absorb the resonance radiation from an external gold, hollow-cathode source. If the square root of the relative yield is plotted vs target voltage, a linear portion is found between 40 and 70 v. The extrapolation of the linear portion of the curves gives rise to an average intercept energy E_E of 29 ev at low pressures. The discharge chamber is specially designed to permit consecutive measurements of the sputtering yields by the absorption and by a previously employed emission technique under identical chamber geometry and discharge conditions. In the direct comparison of results possible thereby, the average value of E_E from the emission curves is 29.5 ev, which is approximately equal to the above absorption value of 29 ev. The plasma potential for these experiments is found to be about 12 ev. Moreover, the curves themselves are proportional over the range of 40 to 100 v. These results strongly indicate that E_E is an experimental invariant from which reliable threshold energies can be obtained. This coincidence of curves also indicates that the variation of excitation probability of the Au atoms with different ion and correspondingly different atom energies does not affect the emission yield curves. The sensitivity of the absorption method with the present hollow cathode is slightly poorer than that of the emission method. The observed increase in the slope of the absorption square root yield curve with increased discharge current is attributed to imperfect resonance which may be due to the difference in argon pressures and discharge currents within the gold, hollow cathode source, and those within the sputtering single-crystal target chamber. (auth)

4838 PERFORMANCE OF THE PLASMA THETA-PINCH FOR LASER PUMPING. S. Aisenberg, D. V. Missio, and P. A. Silberg (Raytheon Co., Waltham, Mass.). J. Appl. Phys., 35: 3625-6(Dec. 1964).

A study was made of some characteristics of theta pinches for improved optical pumping of laser crystals. Of particular interest were: (1) the relative light output as a function of capacitor voltage; and (2) the energy coupling efficiency for conversion of stored energy to plasma energy for various gases and pressures. The laser output of a $CaWO_4$ (Nd^{3+}) crystal was studied. (auth)

4839 PERTURBED HARTREE-FOCK CALCULATIONS. IV. SECOND-ORDER PROPERTIES OF THE FLUORINE MOLECULE. Richard M. Stevens and William N. Lipscomb (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 41: 3710-16(Dec. 15, 1964).

The coupled Hartree-Fock method with a limited basis set yielded values at the F nucleus and at the center of charge C of the F_2 molecule for the electric polarizability ($\alpha_{||} = 2.15$ Å^3, $\alpha_\perp = 0.77$ Å^3), the magnetic susceptibility (extrapolated to -10.2 ppm), the magnetic shielding [$\sigma = -276$ at F or -200 at C (preferred value); $\sigma_{expt} = -210$ ppm], rotational magnetic moment (extrapolated to -0.108 nuclear magnetons) and spin rotation constant [$C_F = 169$ at F or 152 at C (preferred value); $C_{expt} = 157 \pm 2$ kc/sec]. The poor gauge dependence for the shielding and spin rotation constant is associated with the unusually high paramagnetic shielding at F which is due specifically to an interaction of the occupied π_u orbital with a low-lying excited σ_u state. The susceptibility and rotational magnetic moment did not vary extensively with change of gauge. (auth)

4840 THE NUMERICAL CALCULATION OF THE CONTRIBUTION FROM FEYNMAN DIAGRAMS FOR THE GROUND STATE ENERGY OF TWO-ELECTRONIC ATOMIC SYSTEMS. U. Safronova and V. Tolmachev (Karpov Inst. of Physical Chemistry, Moscow). Leituvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Leituvos TSR Aukstosios Mokyklos, 4: 13-23(1964). (In Russian)

Field form of the perturbation theory is applied for the calculations of the two-electronic systems in a case, when a zero-approximation energy is not degenerated. The energy correction is calculated in the first and second approximations. It is found that an account at the continuous spectrum is indispensable. (auth)

4841 ANGULAR INTEGRATION OF FEYNMAN DIAGRAMS IN FIELD PERTURBATION THEORY OF ATOMS. A. Bolotin, Y. Levinson, and V. Tolmachev (Karpov Inst., of Physical Chemistry, Moscow). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 25-33(1964). (In Russian)

The spherical symmetry of nondegenerate atomic states (filled shells) is utilized and summation and integration of geometric nature in Feynman diagrams are performed. The angular integration of Coulomb electron-electron interaction matrix elements and summation of these elements over the magnetic quantum numbers lead to a j-coefficient with diagram topologically equivalent the corresponding Feynman diagram. (auth)

4842 METASTABLE IONS IN DOUBLE-FOCUSING MASS SPECTROMETERS. J. H. Beynon, R. A. Saunders, and A. E. Williams (Imperial Chemical Industries Ltd., Manchester, Eng.). Nature, 204: 67-8(Oct. 3, 1964).

It is shown that in a double-focusing mass spectrometer, ions that dissociate before, during, and after their transit of the electrostatic analyzing tube can be distinguished. (T.F.H.)

4843 OLBERS' PARADOX. E. R. Harrison (National Inst. for Research in Nuclear Science, Chilton, Berks, Eng.). Nature, 204: 271-2(Oct. 17, 1964).

Several arguments are proposed to refute Olbers' paradox (viz., that the sky is dark at night). (T.F.H.)

4844 CONSIDERATION OF POLARIZATION AND EXCHANGE IN THE THEORY OF ELECTRON-ATOM COLLISIONS. V. D. Obedkov. Opt. Spectry. (USSR) (English Transl.), 17: 101-4(Aug. 1964). Translated from Opt. i Spektroskopiya, 17: 189-96(Aug. 1964).

Equations are derived for electron scattering by atoms with a complete accounting of polarization and exchange. The correlation with other known approximations is indicated. Moreover, some methods are considered for calculating polarization potentials. (auth)

4845 ELASTIC SCATTERING OF ELECTRONS BY LITHIUM ATOMS IN THE POLARIZATION-EXCHANGE APPROXIMATION. I. Zh. Vinkalns, E. M. Karule, and V. D. Obedkov. Opt. Spectry. (USSR) (English Transl.), 17: 105-8(Aug. 1964). Translated from Opt. i Spektroskopiya, 17: 197-202(Aug. 1964).

The total cross sections for elastic scattering of electrons with energies from 0 to 12 ev by lithium atoms were calculated in the polarization-exchange approximation, in the distorted-wave approximation, and in an approximation which takes polarization into account but not exchange. The calculations confirm the importance of including the polarization in calculations of the cross sections for scattering of slow electrons by alkali metals. Close to zero energy (in the polarization-exchange approximation at an energy ~0.016 ev) the Ramsauer effect is observed. (auth)

4846 QUADRUPOLE STRENGTHS FOR THE 1'S–n'D TRANSITIONS IN He. M. R. C. McDowell and A. D. Stauffer (London Univ.). Phys. Letters, 12: 207-8(Oct. 1, 1964).

The sequence of 1'S → n'D (n = 3 or 4) transitions in He is studied in order to find the difference between the quadrupole strengths calculated by the quadrupole-length and quadrupole-velocity methods. (T.F.H.)

4847 RESONANT SCATTERING OF ELECTRONS BY He^+. P. G. Burke (Atomic Energy Research Establishment, Harwell, Berks, Eng.), D. D. McVicar, and K. Smith. Phys. Letters, 12: 215-16(Oct. 1, 1964).

Calculations of the positions and widths of members of all the resonant series convergent on the second quantum threshold in the elastic scattering of electrons by He^+ for

total angular momenta L = 0, 1, and 2. Electron energies between 2.93 and 2.97 rydberg are considered. (T.F.H.)

4848 EXPERIMENTAL RESULTS ON THE DEPENDENCE OF THE DEGREE OF POLARIZATION OF THE SCATTERING ANGLE IN MOTT-SCATTERING OF SLOW ELECTRONS. H. Deichsel and E. Reichert (Universität, Mainz). Phys. Letters, 13: 125(Nov. 15, 1964). (In German)

The polarization in Mott scattering of 900-kev electrons by mercury was measured as a function of scattering angle. (D.C.W.)

4849 THE KLL AUGER SPECTRUM OF NEON. H. Koerber and W. Mehlhorn (Universität, Munich). Phys. Letters, 13: 129-30(Nov. 15, 1964).

The KLL Auger spectrum of neon was measured. The absolute energies and relative intensities of the KLL Auger lines were obtained, and the relative intensities were compared with theoretical values. (D.C.W.)

4850 MONOCHROMATIC FAST ELECTRONS PRODUCED BY A FILTER LENS. W. A. M. Hartl (Universität, Hamburg). Phys. Letters, 13: 133-4(Nov. 15, 1964).

The energy distribution of thermionically emitted 30-kev electrons was reduced to less than 0.1 of its original value using a filter lens—an axially symmetric electrostatic system with three electrodes. The method is described, and preliminary results of measurements of electron energy losses in Ag and Al foils are presented. (D.C.W.)

4851 CHOICE OF CHARGE-CHANGING GASES FOR NEUTRAL BEAM INJECTORS. A. B. Wittkower, P. H. Rose, N. B. Brooks, R. P. Bastide, and L. Hopwood (High Voltage Engineering Corp., Burlington, Mass.). Phys. Letters, 13: 134-5(Nov. 15, 1964).

The equilibrium neutral atomic fraction and the attachment scattering angle were measured for D, He, and H beams at 30 kev in several charge-changing gases and vapors. A figure of merit for selecting a gas for formation of a neutral beam prior to injection into a tandem accelerator was defined and evaluated. Values for the production of H^0 in He and H_2 gases by hydrogen beams at 10 to 55 kev were also obtained. (D.C.W.)

4852 EXCITATION OF MOLECULAR ROTATION BY SLOW ELECTRONS. K. Takayanagi and S. Geltman (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Letters, 13: 135-7(Nov. 15, 1964).

The effective cross section for excitation of molecular rotation by electron impact was calculated in the distorted-wave Born approximation. The results for the rotational excitation ($0 \rightarrow 2$) of H_2 and N_2 are discussed in relation to other calculations. (D.C.W.)

4853 EXTREME ULTRAVIOLET SPECTRA FROM MULTIPLY-IONIZED NEON BEAMS. S. Bashkin (Univ. of Arizona, Tucson), L. Heroux, and J. Shaw. Phys. Letters, 13: 229-31(Dec. 1, 1964).

The accelerator technique for studying atomic spectra was extended into the extreme ultraviolet. A beam of Ne^{2+} at 5.1 Mev was obtained with a 3 Mv Van de Graaff generator containing a gas stripper canal 300 kv below the ion source potential. Identification of the observed lines in neon is discussed. (C.E.S.)

4854 EXPERIMENT ON THE RESONANCE IN THE ELASTIC SCATTERING OF ELECTRONS BY ATOMIC HYDROGEN. G. J. Schulz (Westinghouse Electric Corp., Pittsburgh). Phys. Rev. Letters, 13: 583-5(Nov. 16, 1964).

Experimental evidence is reported for a resonance in the elastic scattering of electrons by atomic hydrogen, below the onset of excitation of the electronic states of hydrogen. A transmission experiment was used in which an electron beam is transmitted through the gas at higher pressures such that electrons make many collisions along the way and in which only the unscattered electrons are measured. (C.E.S.)

4855 ELECTRON- AND PHOTON-IMPACT IONIZATION OF O_2. J. William McGowan, E. M. Clarke, Harold P. Hanson, and R. F. Stebbings (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev. Letters, 13: 620-2(Nov. 23, 1964).

The ionization of O_2 by electron impact was investigated; the results were compared with observations on ionization of O_2 by photon impact. An ionization potential of 12.04 ± 0.02 ev was obtained, and the existence of the same processes in both electron- and photon-impact ionization was established. The results show that through the first electron volt above the ionization threshold of O_2, autoionization is the dominant process. (D.C.W.)

4856 TRANSMISSION RANGE OF FAST IONS IN DIAMOND STRUCTURES. Claus Poehlau, Hans Lutz, and Rudolf Sizmann (Technische Hochschule, Munich). Z. Angew. Phys., 17: 404-6(Aug. 1964). (In German)

The range of 80-kev ^{85}Kr ions in gallium arsenide single crystals was determined. The diamond lattice structure of this compound suggested an extended range in the (110) direction, which was found experimentally. It was found that the crystal structure of the gallium arsenide was rapidly destroyed under ion bombardment. Extended ranges no longer occurred; a normal range distribution free of structural effects was observed. The mean penetration depth of the 80-kev Kr ions was 233 Å. (tr-auth)

4857 SCATTERING OF 25-kev ELECTRONS ON GASES. III. SCATTERING ON MOLECULAR HYDROGEN. J. Geiger (Technische Universität, Berlin). Z. Physik, 181: 413-25(1964). (In German)

The angular distribution of 25-kev electrons scattered elastically and inelastically by molecular hydrogen was measured. By the separation of the inelastically scattered electrons, observation of deviations from the Debye-Ehrenfest theory of the electron diffraction by molecules at small angles is possible. These deviations are due to the alteration of the electron density distribution of the hydrogen atoms induced by the bonding. The energy loss spectra at different scattering angles (energy resolution ≈ 1 ev) show a strong peak at $\Delta E = 12.6$ ev. At larger angles for $\Delta E > 15$ ev, a continuum appears. That part of the inelastic processes which leads to ionization of the molecule is increasing with increasing scattering angle. Normalization of the experimental values to the theoretical elastic differential cross section permits comparison of the angular distribution of the 12.6-ev energy loss with the distribution calculated by Roscoe. The shape of the experimental curve is in fairly good agreement with the calculated curve, but the experimental values at small angles are 20 to 30% higher. For zero angle the energy loss spectrum is obtained with better resolution (≈0.04 ev). It shows vibrational states of the Lyman and Werner band and higher terms. The calculated probability of the excitation of some vibrational states of the Werner band (square of the overlap integral) is in excellent agreement with the measurement, while Hutchisson's result fails for the Lyman band. (auth)

4858 ELEMENTARY PROCESSES IN ATOMIC COLLISIONS INVOLVING A CHANGE IN THE CHARGE STATE. V. V. Afrosimov, Yu. S. Gordeev, M. N. Panov, and N. V. Fedorenko (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1637-44(Sept. 1964). (In Russian)

Coincidence measurements were made of differential cross sections for atomic charge-exchange processes. Single collisions of 50-kev Ar^+ ions with argon atoms were investigated. Cross sections of elementary processes in collisions with impact parameters smaller than atomic magnitudes were measured for various discrete saturation energy losses. It was found that the number of electrons removed under various collision conditions may be approximated by a universal function similar to that for normal distribution. Correlations showed that the initial particle charge does not play any special role. (R.V.J.)

4859 ON THE INFLUENCE OF MULTIPLE COLLISIONS ON ATOMIC HYDROGEN EXCITATION BY CHARGE

EXCHANGE OF PROTONS AND DISSOCIATION OF H_2^+ AND H_3^+ IN HELIUM AND NEON. V. A. Ankudinov, S. V. Bobashov, and E. P. Andreev (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1645-8(Sept. 1964). (In Russian)

Spectral intensities of H_α, H_β, H_γ, and H_δ lines in the hydrogen Balmer series, appearing during proton and 10 to 30 kev H_2^+ and H_3^+ passage through helium and neon, were studied as functions of gas pressure. The data revealed that in multiple collisions between the ion beam and the target gas atoms the amount of highly excited hydrogen in the fast particle beam was reduced. (R.V.J.)

4860 THE DEVELOPMENT OF A LOW-VOLTAGE ARC IN CESIUM VAPOR. M. A. Lebedev. Zh. Tekhn. Fiz., 34: 1705-9(Sept. 1964). (In Russian)

Preliminary data are given from experimental studies of low-voltage arc development. The design of a discharge chamber constructed of molybdenum glass with a heated cathode is given, and v-amp characteristics at cathode temperatures of 700, 500, and 350°C are plotted for various cesium vapor pressures. (R.V.J.)

4861 X-RAY INVESTIGATION OF THE TRANSITION I → II OF HN_4I AT TEMPERATURES BETWEEN 22° AND −163°C. V. Hovi and M. Varteva (Univ. of Turku, Finland). 7p. (CONF-651-22)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Lattice parameters of HN_4I were investigated at temperatures between 22 and −163°C by x-ray diffraction. The change of the molar volume at the transition I → II was determined, and values were obtained for the cubic thermal expansion coefficients of the modifications I and II. Also, the rate of the transition I → II of HN_4I was observed as a function of supercooling and of particle size by using a low-temperature x-ray diffractometer. Data are tabulated and the results are discussed. (P.C.H.)

4862 LINE WIDTH TRANSITIONS IN THE DEUTERON MAGNETIC RESONANCE OF POLYCRYSTALLINE ND_4Cl AND ND_4Br. V. Hovi and P. Pyykkoe (Univ. of Turku, Finland). 5p. (CONF-651-30)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Line width transition temperatures were determined for ND_4Cl and ND_4Br and, in the same connection, the principal origin of the line broadening above the transition temperatures was investigated. The results showed the line width to be constant from room temperature down to 200°K for ND_4Cl and down to 172°K for ND_4Br. The maximum error was estimated to be ±10°K. Below the transition temperature, the line was found to broaden with decreasing temperature, and at about 175°K for ND_4Cl and 150°K for ND_4Br the lines were longer observable. Above the line width transition temperature, the lines had a closely Gaussian shape. In addition, the transition II ⇄ III both in ND_4Cl and in ND_4Br had no observable effect on the lines. The higher line width transition temperatures of ND_4Cl and ND_4Br as compared to those of the ordinary ammonium halides were attributed to the increase of the moment of inertia of the ammonium ion. (P.C.H.)

Cosmic Radiation

Refer also to abstracts 5076 and 5079.

4863 (FTD-TT-64-1077(p.100-72)) CERTAIN PROBLEMS AND FUTURE PROSPECTS FOR INVESTIGATIONS OF COSMIC RAYS. N. L. Grigorov, I. D. Rapoport, I. A. Savenko, and G. A. Skuridin. Translated from Kosmich. Issled., 2: 724-62(1964).

The basic problems involved in the operation of an ionization calorimeter, an instrument used to measure the energy of cosmic particles, and the relation between the basic parameters of the ionization calorimeter and the conditions of its utilization are considered. In addition, the possibilities of employing an ionization calorimeter to study a number of the characteristics of reactions between atomic nuclei and cosmic particles with energies of 10^{11} to 10^{13} ev, for the study of the composition of high-energy primary cosmic particles (10^{11} to 10^{14} ev), for the study of the electron component of primary cosmic rays, and for the study of high-energy γ radiation, were considered. (auth)

4864 (FTD-TT-64-1077(p.200-6)) SPECTRUM OF VERY HIGH-ENERGY ELECTRONS ARISING IN THE β-DECAY OF THE ALBEDO NEUTRONS. A. I. Ershkovich (Yershkovich). Translated from Kosmich. Issled., 2: 779-82(1964).

The equilibrium integral spectrum of β-electrons in the case of energies of the order of several Mev is calculated. It is demonstrated that this spectrum agrees with the experimental results obtained in the area of the outer radiation zone. (auth)

4865 CORRELATION COEFFICIENTS AND THE INTERPRETATION OF UNDERGROUND OBSERVATIONS OF COSMIC RAY VARIATIONS. L. I. Dorman. Geomagnetizm i Aeronomiya, 4: 402-4(1964).

Direct computations of the integral multiple generation of mesons (μ) and the corresponding correlation coefficients for underground observations based on the latest theory of the elementary interaction of nucleons (with loss in ionization and meson decay considered) indicate that correlation coefficients determined previously considerably overestimated the effect of high energies and underestimated the effect of low energies. Recomputation of the results obtained from underground observations using correlation coefficients should, therefore, indicate a faster decrease in the primary variation amplitude as the energy of the primary particles increases. As a result, all types of modulation effects virtually disappear for primary energies larger than 100 Bev. (ATD)

4866 PROBING INTERPLANETARY PLASMA AND MAGNETIC FIELDS WITH GALACTIC COSMIC RAYS. U. R. Rao (Massachusetts Inst. of Tech., Cambridge) and Vikram Sarabhai. Planetary Space Sci., 12: 1055-74(Nov. 1964). (MIT-2098-65)

The results of a day-to-day analysis of cosmic-ray daily variation with a very high counting rate meson (μ) detector at MIT are presented. Comparison of these with the daily variation observed by the neutron monitor at Deep River provides a basis for deriving information concerning the position and the energy spectrum of variation of the anisotropy of galactic cosmic rays on each day. The significance of the peak-to-peak amplitude, the time of maximum (T_{max}), and the time of minimum (T_{min}) of the daily variation in relation to the anisotropy is demonstrated, and evidence is presented indicating that from time series of T_{max} and T_{min} it is possible to follow advancing fronts of interplanetary plasma and magnetic fields. The nature of the anisotropy is analyzed, and arguments are advanced for the view that a single virtual source is inadequate to explain the results. Having demonstrated the day-to-day changes of energy spectrum of anisotropy and the level of isotropic galactic intensity, an attempt is made to identify distinct physical states of interplanetary space in terms of a model involving a solar wind, but with nonuniformity of velocity over different regions of the Sun and with a possibility of a blast wave propagated through it due to occasional sudden release of energy. The classification of days as belonging to one or the other of four states is performed by using geomagnetic data and the day-to-day modulation of isotropic galactic intensity. It is then found that the anisotropy associated with different states is quite distinctive and is consistent with what may be expected according to the model. It is suggested that by using data on geomagnetic disturbances and galactic cosmic rays as probes, distinct electromagnetic states of interplanetary space can be identified. (auth)

4867 THE ENERGY SPECTRUM OF THE HEAVY PRIMARY COSMIC RAYS. A. C. Durney, H. Elliot, R. J. Hynds, and J. J. Quenby (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A, 281: 553-64(Oct. 6, 1964).

The magnetic rigidity spectrum of primary cosmic rays with $Z \geq 6$, in the rigidity interval from 2.5 to 16.0 Bv, was determined by means of a Cherenkov counter carried in the satellite Ariel. The integral spectrum shows a well-defined change in slope near 8.5 Bv, indicating that this is probably the upper limit to the solar modulation process at this time (May and June 1962). In the rigidity interval covered by these measurements, the integral spectrum is adequately represented by a power law with an exponent ca. 1.2 below 8.5 Bv and ca. 1.5 above this rigidity. Under the plausible assumption that the integral galactic spectrum of these particles is represented by a power law with exponent 1.5, it follows that the solar modulation process in the 2.5 to 8.5 Bv region is of the form $J_E = J_\infty(p/p_0)^{0.3}$, where J_E is the intensity at the earth of particles with rigidity greater than p in Bv, J_∞ is the corresponding intensity outside the solar system, and $p_0 \sim 8.5$. (auth)

4868 ON THE PRIMARY RIGIDITY SPECTRUM DURING THE MAIN PHASE OF THE FORBUSH DECREASE IN THE COSMIC RADIATION. Hachiro Takahashi (Iwate Univ., Morioka, Japan). Rept. Ionosphere Space Res. Japan, 18: 83-91(1964).

The relation between the differential primary rigidity spectrum during the main phase of the Forbush decrease in the cosmic radiation and the magnitude of geomagnetic storm associated with the Forbush decrease was studied statistically by using the spectrum obtained by Lockwood. It is shown that the differential primary rigidity spectrum given by Lockwood is suitably written as $j_F(P,t_F) = j(P,t)\,[1-C(t_F)\,\{P^{-1} + f(\Delta H)\}]$, where $f(\Delta H)$ is the function of the magnitude of geomagnetic storm and is expressed as $\alpha e^{-\lambda\cdot\Delta H} + \beta$ (α, λ and β: const.) in the case of geomagnetic storm less ~250γ at Kakioka, while $f(\Delta H) = 0$ in the case of Forbush decrease accompanied by geomagnetic storm larger than ~250 γ at Kakioka. When the effect of the storm-time intensity increase in the cosmic radiation is taken into consideration in the study, $f(\Delta H)$ undergoes a considerable change. (auth)

4869 EXPLODING GALAXIES. Allan R. Sandage. Sci. Am., 211: 38-47(Nov. 1964).

Optical and radio observations (particularly on the radio-emitting galaxy M 82) indicating that cosmic rays originate in galactic explosions are discussed, together with associated theoretical considerations. (D.C.W.)

Direct Energy Conversion

4870 (BNL-8199) SUMMARY OF DIRECT CONVERSION WORK. J. R. Powell, J. P. Palmer, M. S. Zucker, W. W. Becker, and M. Maresca (Brookhaven National Lab., Upton, N. Y.). Mar. 1964. Contract AT-30-2-GEN-16. 59p. Dep.(mn); $3.00(cy), 2(mn) OTS.

On the basis of preliminary work, liquid-metal-slug MHD generators seem very attractive for high-temperature power generation in the 2000°F range as either space or commercial topping power cycles. Cycle efficiencies on the order of 20% at approximately 1 lb/kw, with high reliability, seem realizable. The program envisions further study of slug stability problems, generator efficiency, and transformer performance on small (~10 kw) room-temperature NaK generators of both the reciprocating and once-through type. (auth)

4871 (MND-P-2762) FINAL SAFETY EVALUATION OF A SIXTY-WATT STRONTIUM-90 FUELED GENERATOR FOR A U. S. COAST GUARD AUTOMATIC LIGHT STATION. SNAP-7B. V. G. Kelly and H. N. Berkow (Martin-Marietta Corp. Aerospace Div., Baltimore). Apr. 1962. Contract AT(30-1)-2345. 52p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A safety evaluation was performed to determine the mechanical, thermal, and radiation integrity of the SNAP 7B thermoelectric generator. The evaluation included analyses to assess the radiological effects of an accidental fuel release, should the unit be dropped in a water environment. The shielding of the generator was evaluated to determine the safe working limits for personnel required to be near the generator. The detailed areas investigated and the results are as follows: (A) The radiostrontium fuel is confined by two separate containers designed to withstand the external pressure occurring at 12,000 feet of water. Hydrostatic tests have been performed on simulated inner containers to substantiate the analytical study. (B) The thermal integrity of the unit will be maintained in the event of soil burial or a standard one-hour fire as defined by the AEC. (C) The generator unit can withstand forces imposed upon impact during transportation by truck carrier. (D) The chemical stability and relative insolubility of the fuel compound prevents it from causing a radiobiological hazard even if containment is lost in a sea environment. (E) Corrosive action of sea water combined with the maximum hydrostatic pressure will expose the fuel in approximately 510 years. By that time, the activity of the fuel will have decayed to less than one Curie. (F) The radiostrontium is shielded sufficiently for shipment under I.C.C. regulations. In addition, personnel can work on or around the unit's surface for a sufficient length of time to make extensive repairs if necessary. (G) Ionizing radiations from the fuel will have a negligible effect upon the structural integrity of the generator materials. (H) Strict quality control procedures have been adhered to throughout manufacturing and assembly to insure conformance with all specifications. It is concluded that the safety criteria are met and there is reasonable assurance that this generator is safe for its intended use. (auth)

4872 (NP-14505) ONE-DIMENSIONAL UNSTEADY POTENTIAL MHD FLOW. F. Cap and F. Herrnegger (Innsbruck, Universität). [nd]. 7p. Dep.(mn).

The differential equation describing the potential for isentropic, adiabatic, isenthalpic plasma flows is solved in the one-dimensional unsteady case. A quasi-linear equation, characteristic of the boundary conditions, is considered. Approximate solutions are shown. (R.E.U.)

4873 (ORNL-3605(Vol.2)(p.316-52)) THE APPLICATION OF ALKALI METAL VAPOR SYSTEMS TO MHD SPACE POWER GENERATORS. Bernard Hoffman and Frederick Shair (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.).

A description is given of a theoretical and applied research program directed toward prolonging the lifetime of magnetohydrodynamic (MHD) energy converters by reducing the necessary operating temperatures to the range 1000–2000°K. The process of interest is the use of the magnetically induced electric field in the MHD generator for electrical breakdown of appropriate working fluids. Work was directed toward the use of alkali metals for Rankine (vapor) cycles (although the results are applicable to Brayton cycles with certain nuclear reactors) and alkali metal seeded nozzle gases for studying the basic parameters of the breakdown. (auth)

4874 (ORNL-3605(Vol.1)(p.353-70)) ANALYSIS OF THE ACCELERATION OF LITHIUM IN A TWO-PHASE NOZZLE. David G. Elliott (California Inst. of Tech., Pasadena. Jet Propulsion Lab.).

To generate electric power magnetohydrodynamically from a liquid metal in a closed cycle, the metal must first be accelerated to several hundred feet per second in a two-phase nozzle. Results are presented of calculations on the acceleration of lithium by cesium vapor in a two-phase nozzle. The calculations indicate that 85 to 90% of isentropic velocity can readily be attained, and this conclusion is supported by experiments on the acceleration of water by nitrogen and by Freon. (auth)

4875 THEORETICAL PERFORMANCE COMPARISON OF WORKING FLUIDS IN A NONEQUILIBRIUM MHD GENERATOR. F. H. Shair (General Electric Co., Philadelphia). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1883-5(Nov. 1964).

Results of preliminary calculations are presented, based upon the theory of magnetically induced ionization, which

indicate the relative performances of various systems under consideration for use in such nonequilibrium MHD power generators. All the alkali metal vapors and various seeded gas systems are considered. The flow is one-dimensional steady state with constant Mach number. The electrodes within the generator are assumed to be perfectly segmented. Because of much smaller elastic electron collision cross sections in hydrogen, helium, argon, and mercury, as compared to that of the alkali metals, the magnetic fields necessary to create the same power density are generally much lower in the former group as compared to equivalent systems in the latter group. A comparison of the alkali metal systems shows that the decrease in the ionization potential of the heavier elements is greatly overshadowed by the increase in atomic weight and especially by the increase in electron-neutral cross section. However, considering vapor pressure and dimer formation, potassium appears to be the best choice among the alkali metals as an MHD working fluid. Non-equilibrium potassium MHD generators, using only the phenomena of magnetically induced ionization, will probably require magnetic fields near 100 kgauss to produce power densities near 1 kw/cm^3. (auth)

4876 EXOTIC POWER SOURCES. J. Kohl. Elec. West, 131: 38-41(July 1964).

The operating principles of controlled fusion, MHD, thermionic emission fuel cells, and thermoelectric generators are outlined. Anticipated efficiencies and sizes, fuels and heat sources required, applications, and current status of research are discussed. (auth)

4877 RECENT PROGRESS IN MPD POWER. B. C. Lindley (International Research & Development Co. Ltd., Newcastle-upon-Tyne, Eng.). Euro Nucl., 1: 29-34(Sept. 1964).

A number of magnetoplasmadynamic generation demonstration units have operated in the USA, the UK, France, Japan, and elsewhere, and generators burning fossil fuels are moving towards the engineering prototype stage with multi-megawatt experiments. The closed-cycle concept is at an early research stage, but offers a number of advantages. Non-equilibrium ionization, working fluids, pressure levels, magnetic field requirements, and attainable specific powers are discussed. It is concluded that the direct open-cycle fired MPD-steam plant is likely to be developed to a first prototype commercial power station in 10 to 12 years, and may initially demonstrate an overall efficiency approaching 50 per cent, with a later prospect of up to 60 per cent. (auth)

4878 LIMITS ON COLLISIONLESS MODEL OF THERMIONIC CONVERTER. C. M. Goldstein (Lewis Research Center, Cleveland). J. Appl. Phys., 35: 3629-30 (Dec. 1964).

Current-voltage characteristics for gaseous thermionic diodes were computed by using the collisionless Langmuir space-charge theory modified to include both ion and electron emission at the cathode. (auth)

4879 EXTRATHERMAL ELECTRICAL CONDUCTIVITY MEASUREMENTS IN A MAGNETOPLASMADYNAMIC GENERATOR. I. R. McNab (International Research and Development Co., Ltd., Newcastle upon Tyne, Eng.). Nature, 204: 275-6(Oct. 17, 1964).

Electric power generation tests are reported on a magnetoplasmadynamic generator configuration using Cs-seeded He as the working fluid, and Ta electrodes. Electric conductivity measurements in the generator indicate that thermionic emission by the electrodes is enhanced by Cs deposition on the Ta. (T.F.H.)

4880 THERMIONIC GENERATOR FOR RE-ENTRY VEHICLES. A. R. LeBlanc and W. W. Grannemann (Univ. of New Mexico, Albuquerque). Proc. IEEE (Inst. Elec. Electron Engrs.), 52: 1302-10(Nov. 1964). (TID-18086; SCDC-3087)

A thermionic generator for use on re-entry vehicles was analyzed analytically and experimentally. Equations were derived for prediction of the output current, output power, and conditions of maximum power for the device. The electrical power output potential of a typical re-entry vehicle was obtained by solving the temperature history of a thin-walled emitter. Given the wall temperature and the work function, the saturated Richardson current is easily obtained. Other parameters needed for predicting output power are obtained from curves in the literature. To simulate re-entry conditions, a test model was build and inserted in either a nitrogen or argon plasma jet. Graphite, thoriated tungsten, tungsten and molybdenum were used for the emitter and collector. Of the materials tested, graphite was the only material that met, to some degree, the qualifications needed for operation of the hypersonic plasma thermionic generator. (auth)

4881 AN INSTRUMENT FOR THE MEASUREMENT OF THERMOELECTRIC CONVERTER INTERNAL RESISTANCE. David J. Sobo (Atomics International, Canoga Park, Calif.). New York, Instrument Society of America, 1964, Preprint 11.2-4-64, 7p. (CONF-701-5)

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

An instrument developed for measuring the internal resistance of the SNAP-10A thermoelectric generator under operating conditions is described. The practical and theoretical considerations on which the unit is based are outlined. (D.C.W.)

4882 ATOMIC BATTERY AND TEST INSTRUMENT. Nicholas Viszlocky. U. S. Patent 3,149,236. Sept. 15, 1964. Filed Jan. 4, 1962.

Development of a portable, hand-carried, nuclear-powered battery is described. A radioactive light source is combined with at least one photocell. The photocell is provided with leads so that current-utilizing devices can be attached to it. Suitable shielding is provided around the battery. Advantages of ^{90}Sr-activated fluorescent light sources for use in this battery are discussed. (M.C.G.)

4883 MAGNETOHYDRODYNAMIC GENERATOR CONFIGURATION. James D. Cobine and Lawson P. Harris (to General Electric Co.). U. S. Patent 3,149,247. Sept. 15, 1964. Filed Oct. 6, 1960.

A magnetohydrodynamic generator was designed which eliminates the undesirable aspects caused by Hall-effect currents. It has a high voltage output for the given power rating and utilizes the Hall-effect current to supply an external load without loss of power due to instability. The generator has a fluid-flow channel with a rectangular cross section. The channel is provided with segmented electrodes spaced at intervals along the direction of flow. Each electrode has a corresponding electrode placed across the flow channel to form an electrode pair. Each pair is electrically connected by solid conducting material to complete a current path for the transverse electric current generated by the passage of an ionized fluid through the magnetic field. The Hall current generated axially by the transverse current is utilized to supply an electric load by connecting the load between selected axially displaced electrodes. The current in the shorting conductors provides the resistance to fluid flow and thus establishes the desired pressure gradient for the conversion of the energy contained in the fluid to electric energy. The Hall current, flowing parallel to the direction of fluid flow, is then utilized to supply an external electric load. (M.C.G.)

4884 METHOD OF AND MEANS FOR GENERATING ELECTRICAL ENERGY. Agust Valfells. U. S. Patent 3,149,248. Sept. 15, 1964. Filed Apr. 3, 1961.

A means was developed for converting nuclear into electric energy. A fissionable isotope and a material with low ionization potential are carried by a gas. The gas is heated by the fissioning of the isotope so that it is thermally ionized and caused to expand so as to have a velocity. The gas is directed, in a jet stream, through the magnetic field in such a manner that an electric potential is established across the gas stream. This electric potential is utilized. The heat and fission products are re-

moved from the gas, the isotope replenished, and the gas recycled. Mixtures of $^{235}UF_4$ and UI_3 may be used for the process. (M.C.G.)

4885 ELECTRIC POWER GENERATION. James M. Lafferty, James D. Cobine, and Thomas A. Vanderslice (to General Electric Co.). U. S. Patent 3,149,249. Sept. 15, 1964. Filed Apr. 17, 1961.

A method was developed by which the power output of magnetohydrodynamic generators may be increased without increasing the temperature of the gaseous conducting medium. A gaseous fluid is conducted along a flow path. A material whose atoms have at least one metastable energy level is injected into the gaseous medium. The energy levels of these atoms are raised to their metastable state. An easily ionizable second material is afterwards injected into the gaseous fluid and atoms of this second material are ionized by collisions with the atoms of the first material in their metastable state. (M.C.G.)

4886 MAGNETOHYDRODYNAMIC INDUCTION DEVICE. Emmeth A. Luebke (to General Electric Co.). U. S. Patent 3,149,250. Sept. 15, 1964. Filed Dec. 9, 1960.

The design of an alternating-current magnetohydrodynamic electric power generating apparatus is described. It is electrodeless, the magnetic field is applied to an oscillating conducting fluid, and the conducting fluid may be re-used continuously. A means is provided for defining an annular flow passage, closed at both ends, for a conductive fluid. A steady radial magnetic field is impressed across the flow passage. Means are provided to cause the conducting fluid to flow alternately in opposite directions through the magnetic field. (M.C.G.)

4887 ELECTRIC POWER GENERATION. Henry Hurwitz, Jr. (to General Electric Co.). U. S. Patent 3,149,251. Sept. 15, 1964. Filed Apr. 17, 1961.

A method was developed for generating electric power. An easily ionizable material is injected into a gaseous fluid; then a second material whose atoms have at least one metastable energy level is injected. The energy levels of these atoms are raised to the metastable state, and the atoms of the first material are ionized by collisions with the metastable atoms. The gaseous fluid mixture flows through a magnetic field so that electric current flows through the mixture. This provides a method for generating electric power in an MHD apparatus in which the degree of ionization is not dependent solely on the temperature to which the gaseous conducting medium is heated. (M.C.G.)

4888 ELECTRIC POWER GENERATION. Marshall Lapp (to General Electric Co.). U. S. Patent 3,149,252. Sept. 15, 1964. Filed Apr. 17, 1961.

A method was developed for increasing the power output of magnetohydrodynamic generators without increasing the temperature of the gaseous conducting medium by maintaining ionization for a longer time throughout the generating process than heretofore possible. An ionizable material and a material whose atoms have at least one metastable energy level comparable to the ionization energy level of the first material are injected into a gas. The energy levels of the atoms of the second material are raised by irradiation with light to a metastable level. Atoms of the first material are ionized by collisions with these metastable atoms. The gas mixture is passed through a magnetic field so that electric current flows through the gaseous mixture. (M.C.G.)

4889 ELECTRODE STRUCTURE FROM MAGNETOHYDRODYNAMIC DEVICE. Emmeth A. Luebke (to General Electric Co.). U. S. Patent 3,149,253. Sept. 15, 1964. Filed Jan. 3, 1962.

An electrode structure was designed which is especially adapted for use in an MHD device. It is made of ceramic material and does not substantially impede the flow of electric current in the electrode. Powdered refractory materials were compacted or sintered with certain additives to produce a structure having improved mechanical and electrical properties at ordinary temperatures as well as at extremely elevated temperatures. It consists of a bonded mass of thermionic emitting particles having a conducting network of refractory metal filaments dispersed throughout the mass. (M.C.G.)

Elementary Particles and Radiations

4890 (AD-606994) A STUDY OF THE K^+ LIFETIME AND THE LONGITUDINAL POLARIZATION OF THE MUON IN $K^+_{\mu 2}$ AND $K^+_{\mu 3}$ DECAY (thesis). Technical Report No. 36, Carroll A. Quarles, Jr. (Princeton Univ., N. J.). Sept. 21, 1964. Contract Nonr-1858(06). 97p. $3.00(OTS).

A precise measurement is made of the K^+ lifetime and the lifetime of the $K^+_{\mu 2}$ decay mode. The longitudinal polarizations of the muon in $K^+_{\mu 2}$ decay and at two values of the muon energy in $K^+_{\mu 3}$ decay are also measured. Lifetime data are analyzed with a view toward checking for deviations from a pure exponential decay law. No evidence is found for such deviations. The mean lives are measured to be $\tau(K^+) = (12.443 \pm 0.038)$ nanoseconds, and $\tau(K^+_{\mu 2}) = (12.501 \pm 0.087)$ nanoseconds. The longitudinal polarization of the muon in $K^+_{\mu 2}$ decay was found to be -1.01 ± 0.12. That is, the muon is essentially 100% polarized with its spin antiparallel to its momentum in agreement with the assumptions of spin zero for the K^+ and the two-component theory of the neutrino. For the longitudinal polarization of the muon in $K^+_{\mu 3}$ decay, we found $P = +0.7 \pm 0.6$ at a muon energy of (191 ± 4) Mev and $P = -0.6 \pm 0.7$ at (231 ± 4) Mev. These data, taken together with other measurements of this polarization, are consistent with the constant-form-factor theory with $\xi = 0.5$ and with a partially conserved strangeness-changing vector current theory. (auth)

4891 (JINR-P-1781) ELEKTROMAGNITNYE VZAIMODEISTVIYA (TEORIYA). (Electromagnetic Interactions (Theoretical)). A. M. Baldin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 34p. (CONF-550-66). Dep.(mn).

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The many papers published during the last two years represent, as a general rule, further elaboration of previously expressed ideas. Many successful experiments were carried out during that time period. The theoretical studies which affected directly the experimental investigations are reviewed, covering in greater detail the field of papers presented at the Conference. The relation between electromagnetic interaction and high-energy physics in general is discussed, considering in particular the theory of the high-energy particles, illustrated by the method of complex angular moments. The following fields are considered as forming the basis of electromagnetic interactions: perturbation theory, dispersion relations, and resonance approximations. The purpose of most of the experimental work reviewed is the determination of the interaction constants and other characteristics of particles and resonances. Systematization of these data may clarify the problem of symmetry. The problems examined included unitary symmetry, interaction of electrons with nucleons, form factors, electromagnetic interaction of 2- and 3-nucleon systems, scattering phenomena, and electrodynamic studies, including experiments, the results of which deviate from predicted values. (Review article. 46 references). (TTT)

4892 (JINR-P-1785) NUKLON-NUKLONNOE I PION-NUKLONNOE VZAIMODEISTVIYA V OBLASTI ENERGII DO 1 Gev. (Nucleon-Nucleon Interaction Below 1 Gev). Yu. M. Kazarinov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 42p. (CONF-550-67). Dep.(mn).

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

A review is given of available data on processes in N-N and π-N interactions. Diagrams of the energy dependence of phase shifts in N-N scattering, parameter measurements in p-p scattering at 430 Mev with predictions for phase

analysis, energy dependence of cross sections for π-meson production in p-p interactions, and energy dependence of the coefficient b in π-meson angular distribution $\cos^2\vartheta$ were plotted, as well as cross section energy dependence for π-meson production in n-p interactions. Data on π-p scattering and correlations of Roper and Loveless phase analysis were also plotted. (R.V.J.)

4893 (JINR-P-1788) TEORIYA PION-NUKLONNOGO VZAIMODEISTVIYA V OBLASTI ENERGII NIZHE 1 Gev. (Pion-Nucleon Interactions (Up to 1 Gev)). D. V. Shirkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 22p. (CONF-550-62). Dep.(mn).

From The International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The dynamics of π-π and π-N interactions to 1 Bev were studied by the bootstrap method, taking into account mesonic resonance. (R.V J)

4894 (JINR-P-1789) SLABYE VZAIMODEISTVIYA STRANNYKH CHASTITS. (Weak Interactions of Strange Particles). I. V. Chovilo (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 71p. (CONF-550-68). Dep.(mn).

From The International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

Theoretical problems of weak interactions of strange particles were reviewed, considering SU(3) symmetry and selection rules for changing electric charge (ΔQ) in lepton decay with ΔS = I and for changing isotopic spin (ΔI) in strongly interacting particle decay with ΔS = 0 and ΔS = I. Spatial transformation properties of strongly interacting particle fluxes are discussed, and various theoretical predictions are correlated with available experimental data. (R.V.J.)

4895 (JINR-P-1792) PION-NUKLONNYE VZAIMODEISTVIYA V OBLASTI ENERGII VYSHE 1 Gev (TEORIYA). (Interactions of Pions and Nucleons (Above 1 Gev) (Theoretical)). E. L. Feinberg (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 25p. (CONF-550-73). Dep.(mn).

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

An analysis is made of up-to-date data on dispersion relations, virtuality of elastic amplitudes, applications of independent particle models and the concept of unitarity (the effect of competing processes), Bethe-Salpeter equations, and one-pion exchange. The relative role of central and peripheral collisions, the relation of elastic and inelastic processes, and inelastic processes at high energies are discussed, as well as central collisions and quasielastic interactions. (R.V.J.)

4896 (JINR-P-1816) PROTSESSY POGLOSHCHENIYA π^--MEZONOV V VODORODOSODERZHASHCHIKH VESHCHESTVAKH. (Processes of Negative Pion Absorption in Hydrogenous Substances). L. I. Ponomarev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 13p. Dep.(mn).

A scheme is proposed for a unified analysis of processes occurring by the absorption of negative pions in the hydrogenous substances. (auth)

4897 (LNF-64/38) CALCOLO DELLA RELAZIONE RANGE-ENERGIA PER MESONI μ FINO A 10^6 Mev. (Calculation of Range-Energy Relations for μ Mesons up to 10^6 Mev). Note No. 253. R. Scrimaglio and G. Verri (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 24, 1964. 15p. Dep.

The range-energy relations for μ mesons at energies up to 10^5 Bev passing through Al or Mg are calculated. The total energy loss per unit of path is the sum of four independent terms corresponding to four different processes – ionization, bremsstrahlung, pair creation, and nuclear reactions. Each of these is treated separately. The results of the calculation of the total energy loss and the range-energy relation are graphed. (J.S.R.)

4898 (NRS-20) POSITRONIUM CHEMISTRY IN LIQUIDS. II. LIFETIMES, FORMATION, QUENCHING AND COMPOUND FORMATION. S. J. Tao and J. H. Green (New South Wales, Australia. Univ., Kensington). 1964. 17p. Dep.(mn).

The lifetimes of positrons in condensed media are discussed according to whether the positrons annihilate free, in positronium compounds, or in free positronium. The formation and quenching of positronium in mixtures is analyzed and the positronium compound formation fraction is also derived. (auth)

4899 (NRS-21) POSITRONIUM CHEMISTRY IN LIQUIDS. III. OXYACIDS AND HYDROGEN COMPOUNDS. S. J. Tao and J. H. Green (New South Wales, Australia. Univ., Kensington). 1964. 27p. Dep.(mn).

The lifetimes of positrons in the oxyacid–water systems of H_3PO_4, H_2SO_4, $HClO_4$, and HNO_3 with water, and in the hydrogen compound-water systems of HCl, HF, NH_3 and H_2O_2 with water, were determined. Positronium exhibits a slower annihilation rate, λ_2, in the oxyacids and most of the hydrogen compounds studied than in pure water, which is interpreted as a result of the nature of pick-off quenching and the lower molar densities of these compounds. The variation of the values of λ_2 with the concentration of the acid in an oxyacid–water mixture fitted with the theoretical prediction based on the pick-off mechanism. These are further proofs of the existence of positronium (Ps) in condensed media. Some Ps reactions are suggested. The relationship between the intensity I_2 of the long component, the bond strengths of the chemical compound and the resultant Ps compound in a Ps reaction is discussed. From the experimental results, the bond strengths of Ps–O, Ps–OH, Ps–I and Ps–Cl are estimated to be 2.2, 1.3, 2.5, and 2.0 ev respectively. These are weak bonds but they are nevertheless large enough to form stable compounds of positronium. (auth)

4900 (ORNL-3716) STATISTICAL MODEL CALCULATIONS OF NUCLEON-NUCLEON AND PION-NUCLEON COLLISIONS. LABORATORY ENERGY-ANGLE DISTRIBUTIONS ASSUMING ISOTROPY IN THE CENTER-OF-MASS SYSTEM. R. G. Alsmiller, Jr. (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 162p. Dep.; $5.00(cy), 3(mn) OTS.

In a previous report, statistical model calculations for nucleon-nucleon and pion-nucleon collisions were carried out, and results were presented for the center-of-mass energy spectra of both pions and nucleons. These spectra are transformed into the laboratory system on the basis of the assumption that the angular distributions of both nucleons and pions are isotropic in the center-of-mass system. Laboratory energy-angle distributions of nucleons and pions are given for all collision conditions considered in the center-of-mass calculations. (auth)

4901 (ORNL-3717) A STUDY OF HYPERON PRODUCTION BY 430 Mev/c K^--MESONS IN HELIUM. R. B. Muir (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 87p. Dep.; $3.00(cy), 2(mn) OTS.

Thesis submitted to Tennessee. Univ., Knoxville.

The results of a systematic study of hyperon production by 430-Mev/c K^- mesons in a helium bubble chamber is presented. The amounts of the two-nucleon absorption of K^--mesons, multiple π-meson production, internal conversion of Σ-hyperons, and strange particle isobar formation were estimated. No hyperfragments were found. Two-nucleon absorption of the K^- meson comprised (18.8 ± 2.4) per cent of the interactions and two π-meson production (7.1 ± 2.4) per cent. These values were obtained by assuming that secondary π-meson absorptions were insignificant. The Σ- to Λ-hyperon conversion process was found to account for (47 ± 9) per cent of all Λ-hyperons. About one-third of all Σ-hyperons underwent conversion. These values were obtained by examining the momentum distribution of π^--mesons associated with Λ-hyperon emissions. No evidence was found for strange particle isobar formation. The effective mass distribution of the hyperon-meson system for the events fitting the reactions: $K^- + {}^4He \rightarrow \Sigma^\pm + \pi^\pm + {}^3H$; $K^- + {}^4He \rightarrow \Lambda + \pi^- + {}^3He$; and $K^- + {}^4He \rightarrow \Lambda + \pi^0 + {}^3He$ was obtained. The Impulse Model Approximation was used to evaluate the interaction of K^--mesons in flight,

since it was previously found to be an appropriate model for the interactions at rest. For the at-rest interactions, the I.M.A. successfully predicted the final state momentum distributions for Σ-hyperon production. However, in the experiment, it was necessary to assume some of the π-mesons associated with Σ-hyperons scattered off the spectator nucleons. A rough calculation for the relative kinetic energy of the π-meson and the nucleons showed to be at the $T = 3/2$, $J = 3/2$ scattering resonance. In the at-rest interactions, it was not necessary to assume secondary π-meson interactions. There, however, the π-meson-nucleon relative kinetic energy was considerably below the resonance, and good agreement was found between experiment and the I.M.A. The Λ-hyperon events in the at-rest experiment were successfully explained by the I.M.A. and $Y_3^{*-}(1382)$ formation. No π-meson scattering had to be considered. The relative kinetic energy of the π-meson and the nucleons was not at the maximum of the $T = 3/2$, $J = 3/2$ resonance for Λ-hyperon production either in the experiment or at rest. Additional evidence for π-meson secondary scattering was found in comparing the emergence rates of bound nucleon states. In this experiment, it was estimated that the nucleons were left in a bound state for 33.8 per cent of the Σ-hyperon events and 42.2 per cent of the Λ-hyperon events. Emergence rates for the at rest experiment were 63.5 per cent and 56 per cent respectively. The difference between the at-rest and in-flight emergence rates was attributed to π-meson scattering off the residual nucleons. The effect was largest for Σ-production where the π-meson-nucleon relative energy was at the scattering resonance. (auth)

4902 SCATTERING AMPLITUDE OF HIGH ENERGY KLEIN-GORDON AND DIRAC PARTICLES. T. Tietz (Univ. of Lodz, Poland). Acta Phys. Acad. Sci. Hung., 17: 383-5 (1964).

The scattering amplitude for highly relativistic Klein–Gordon particles is derived, demonstrating a method for approximating the wave function of the Klein–Gordon equation. A relation is indicated by which the amplitude for the Dirac case can be calculated from the Klein-Gordon amplitude. (D.C.W.)

4903 NEUTRON FORM FACTORS FROM INELASTIC ELECTRON SCATTERING. P. Kocevar and P. Urban (Universität, Graz). Acta Phys. Austriaca, 18: 255-62 (1964). (In German)

The possibility of a Chew-Low extrapolation of the effective cross section for electron inelastic scattering by deuterons, ^3He and ^3H for the determination of the electromagnetic form factors of the neutron was tested. The extrapolation formulas for these processes were calculated. A discussion of the singularity of the scattering amplitudes shows that under certain assumptions an extrapolation of the effective cross section to the nonphysical range is justified. (tr-auth)

4904 THE EXISTENCE OF W^0 PARTICLES AND ITS CONSEQUENCES. H. Zingl (Universität, Graz). Acta Phys. Austriaca, 18: 263-5(1964). (In German)

The "forbidden" processes of Feinberg and Pais become permitted through the exchange of a W^0 particle. The appearance of the neutrino form factor is shown. The calculation was made neglecting the lepton mass and considering only the most singular term. It is concluded that the Feinberg and Pais formalism can be extended successfully to other regions with convergent results. (J.S.R.)

4905 INELASTIC INTERACTION OF 10-Bev π^- MESONS WITH NUCLEONS. Gerda Haider (Osterreichische Studiengesellschaft für Atomenergie, Vienna). Acta Phys. Austriaca, 18: 320-3(1964). (In German)

The inelastic interaction of 10-Bev mesons (π^-) with protons and neutrons was studied in G5 emulsion stacks. The percentage frequency of the number of secondary tracks was compared with the percentage frequency at 7, 9, and 16 Bev. The mean number of pulses in the center-of-gravity system depends on the multiplicity. The angular distribution of mesons (π) in the π-N center-of-mass system shows a sharp maximum in the forward direction for a low number of secondary tracks. The angular distribution of mesons (π) in the π-π system is almost symmetrical for only 2 or 3 secondary tracks and is sharply asymmetrical for 4 secondary tracks. The central and peripheral collision hypotheses to explain these experimental results are discussed. (J.S.R.)

4906 ISOSPIN CROSSING MATRICES FOR MANY-PARTICLE PROCESSES. Andrzej Kotański, (Jagellonian Univ., Krakow) and Kacper Zalewski. Acta Phys. Polon., 26: 117-27(July 1964).

A rule for evaluating the elements of arbitrary crossing matrices is proved and demonstrated. (D.C.W.)

4907 INVESTIGATION OF THE HIGH ENERGY K^+-p INTERACTION BY THE STATISTICAL THEORY OF MULTIPLE PARTICLE PRODUCTION. I. Kuchtina and R. Raczka (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Polon., 26: 163-7(July 1964).

The energy spectra of particles from $K^+ - p$ interactions at 1.3 and 5 Bev, as well as the energy dependences of the average numbers of particles, were calculated using the Fermi statistical model of multiple production. The contributions of channels with resonant quasi-particles were considered. (D.C.W.)

4908 WHAT ARE ELECTRONS? H. Primas (Eidgenossisches Technische Hochschule, Zurich). Helv. Chim. Acta, 47: 1840-51(1964). (In German)

Definitions of electrons in quantum mechanics and in classical chemistry are discussed and compared. It is indicated that the exactly, mathematically defined concept of quasi-electrons in the sense of the Green function of quantum mechanics corresponds with the electron concept postulated intuitively in chemistry. The possibility of an exact and still clear description of molecules is thus disclosed. (M.C.G.)

4909 POLARIZATION EFFECTS IN COMPTON SCATTERING OF GAMMA RAYS. M. Singh, S. Anand, and B. S. Sood (Pujabi Univ., Patiala, India). Indian J. Pure Appl. Phys., 2: 365-7(Nov. 1964).

Measurements on the azimuthal variation of the intensities of Comptom scattered gamma rays are reported. The results are found to be in good agreement with those calculated from theory. (auth)

4910 THE SYMMETRY OF THE ARRANGEMENT OF THE REST MASS LEVELS OF ELEMENTARY PARTICLES AND RESONANCE STATES. A. Savukynas (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 59-66(1964). (In Russian)

The arrangement of the rest mass levels in the known classes of elementary particles and their resonance states (leptons, mesons, and baryons) is considered on the basis of experimental data. The symmetry of this arrangement in respect of certain levels in groups of the particles with fixed integer values of isotopic spin is found. This symmetry is shown to be a part of the more general one from which the respectivity of the mentioned classes appeared in addition to the respectivity of the levels in them. The existence of some predicted and not finally established states is confirmed from the point of view of the symmetry considered. The new particles of the masses 1040, 1350, and 1460 Mev are shown to be expected. (auth)

4911 MASS AND BINDING FROM DIRECT INTERACTION. W. Guettinger (Universität, Munich), K. Sekine, and J. A. Swieca. Nucl. Phys., 62: 417-33(Feb. 1965).

An exactly soluble model field theory is proposed to describe physical particles on a unified basis. By starting from a direct interaction of Fermi type for particles with vanishing bare mass, the simultaneous increase of both physical mass and binding effects, caused by the interaction, is made explicit. Convergence of the local theory is assured by a resonance effect. The exact solution for the compound-particle is confronted with those obtained from various approximation schemes, viz. one-time and many-time Tamm-Dancoff and Bethe-Salpeter equations. The

coupling of the compound-particle to its constituents is determined. (auth)

4912 POLARIZATION OF PROTONS ELASTICALLY SCATTERED FROM DEUTERONS. R. A. Chalmers, R. S. Cox, K. K. Seth, and E. N. Strait (Northwestern Univ., Evanston, Ill.). Nucl. Phys., 62: 497-510(Feb. 1965).

The polarization of protons elastically scattered from deuterons was measured by a double scattering experiment. Partially polarized protons of energy 1.50, 2.02, and 2.52 Mev were obtained by scattering a 4.1-Mev proton beam from carbon and by subsequent energy degradation in suitable foils. The scattering chamber was filled with a mixture of deuterium, helium, and xenon, and the proton groups corresponding to elastic scattering from the individual gases were resolved in two symmetrically located semiconductor detectors. The simultaneous measurement of right-left asymmetries for xenon, helium, and deuterium permitted a continuous monitoring of false asymmetries, proton beam polarization, and the p-d polarization, respectively. The measurements yield positive polarizations, relatively independent of energy, for p-D scattering at angles (c.m.) between 45 and 120° with maxima of about (8 ± 2)% near 90°, and near zero values at 45 and 120°. These results are consistent with recent n-d polarization experiments of comparable accuracy. (auth)

4913 THE SELF-CONSISTENCY CONDITION AND THE MAGNETIC MOMENTS OF THE NUCLEONS. M. Petras (Komenskeho Univ., Bratislava, Czechoslovakia). Nucl. Phys., 62: 526-8(Feb. 1965).

A new test of the self-consistency in the πN system based on the magnetic moments of the nucleons is considered. (auth)

4914 THE PARTIAL WAVE AMPLITUDE FOR HIGH-ENERGY PION-PION SCATTERING. [PART] II. P. Olesen (Universitet, Copenhagen). Nucl. Phys., 62: 593-614 (Feb. 1965).

The previously formulated approach to the problem of determining the high-energy behavior of the pion-pion partial wave amplitudes is carried one step further. The approach is based on a bootstrap treatment of the inelastic contributions to elastic scattering, and the asymptotic boundary condition is the diffraction picture. Using this boundary condition the integral equation for the inelasticity $R_l^I(\nu)$ is approximated in such a way that it involves $R_l^I(\nu)$ in the high-energy region only. It is argued that the real part of the partial wave amplitude can be calculated in terms of low-energy parameters (in a first approximation), and using the expression obtained in this way for Re $A_l^I(\nu)$ the integral equation for $R_l^I(\nu)$ is solved asymptotically. It turns out that $R_l^I(\nu)$ behaves logarithmic in the asymptotic region, and subtractions are therefore unnecessary in the partial wave dispersion relations. It seems as if the approach involves forces of a central character. The equations determining the high-energy parameters by a low-energy bootstrap requirement are given. In a crude version of the present approach there exists the possibility that all other resonances can be generated from the lowest S-wave resonance. The result obtained for $A_{11}^1(\nu)$ in the high-energy region is compared with what one obtains from the Regge hypothesis; if there is agreement, the present approach gives the same result as is obtained by taking into account only the vacuum trajectory. (auth)

4915 ON THE CORRELATION OF RESONANCE AND INELASTIC THRESHOLD INVOLVING UNSTABLE PARTICLES. Y. Fujii (Nihon Univ., Tokyo). Nuovo Cimento (10), 34: 552-66(Nov. 1, 1964).

The nature of the resonances occurring close to the thresholds of inelastic channels involving unstable particles is investigated with a particular attention to the widths. It is concluded that the width of a peak must be larger than a lower limit of order of the sum of the widths of the unstable particles involved. The correspondence of Λ_{13}^* (1517 Mev, I = ½) and Y_{03}^* (1520 Mev, I = 0) to the thresholds of Λp and $Y_{13}^* \pi$ (1385 Mev, I = 1) respectively, are found not to satisfy this condition. On the other hand a reasonable correspondence seems possible between Y_{11}^* (1660 Mev, I = 1) and $Y_{03}^* \pi$ threshold. (auth)

4916 ELECTROMAGNETIC MOMENTS OF THE INTERMEDIATE VECTOR BOSON AND THE PROCESS $\mu \rightarrow e + \gamma + \bar{\nu} + \nu$. R. C. Brunet (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 34: 599-606 (Nov. 1, 1964).

We calculate the effect, on radiative muon decay, of arbitrary magnetic and electric quadrupole moments for the intermediate vector boson. We find that the differential decay rate is modified to order M_β^2/M_W^2 and M_β^4/M_W^4, respectively. The spectra are examined as possible means of determining the magnetic moment of the $W^\pm$. Unless the vector boson mass is very large, this effect is not beyond detection. We also consider the effect of an electric dipole moment. (auth)

4917 UNITARY COVARIANT EQUATIONS FOR THE BARYON AND PSEUDOSCALAR MESON MASS TENSORS. G. Rosen (Southwest Research Inst., San Antonio, Tex.). Nuovo Cimento (10), 34: 607-18(Nov. 1, 1964).

A unitary covariant theory for the masses of baryons and pseudoscalar mesons is presented in this paper. The conventional group-theoretic notion of exact unitary symmetry is generalized to mean exact unitary covariance for all equations in the theory. Indeed, an exact unitary covariant theory is possible despite the mass differences between the baryons and between the pseudoscalar mesons. It is shown that the particle masses, each accurate to within a few Mev, follow from a simple system of algebraic, unitary, covariant equations. (auth)

4918 POLARIZATION OF Λ-HYPERONS FROM $\gamma + p \rightarrow K^+ + \Lambda$ REACTION. J. Dufour (Faculte des Sciences, Orsay, France). Nuovo Cimento (10), 34: 645-54(Nov. 1, 1964).

A phenomenological model is applied to the reaction $\gamma + p \rightarrow K^+ + \Lambda$ in an attempt to explain the experimental observations for this reaction. In addition to the Born terms and the K^*, the third πN resonance ($F\ ^5\!/_2, ^1\!/_2$) is retained, which gives a polarization for the Λ in accord with experiment. Several sets of parameters that give a good fit to the data, and which correspond to various values for the Λ magnetic moment are proposed. The results are compared with those of other models and with experiment. (tr-auth)

4919 FINAL-STATE INTERACTIONS IN $\eta^0 \rightarrow 3\pi$ DECAY. S. Oneda, Y. S. Kim, and L. M. Kaplan (Univ. of Maryland, College Park). Nuovo Cimento (10), 34: 655-64 (Nov. 1, 1964).

It is shown that the ρ-meson final-state interaction could give rise to the observed asymmetries in the $\eta^0 \rightarrow 3\pi$ decay. A dynamical model is presented, which explains both the branching ratio $P(\eta^0 \rightarrow 3\pi^0)/P(\eta^0 \rightarrow \pi^+ + \pi^- + \pi^0)$ and the existence of a large asymmetric component in the $\eta^0 \rightarrow \pi^+ + \pi^- + \pi^0$ decay. The model predicts a relatively small symmetric constant amplitude. It is shown that, in this model, the symmetric constant amplitude vanishes in the limit of the exact SU_3 symmetry and of a constant η-π coupling. A similar discussion is given for the $K \rightarrow 3\pi$ decay. Possible effects of the σ^0 dipion are also discussed. (auth)

4920 VECTOR-MESON PRODUCTION IN ELECTRON-ELECTRON COLLISIONS. J. H. Baroff (Johns Hopkins Univ., Baltimore). Nuovo Cimento (10), 34: 709-21(Nov. 1, 1964).

The cross section for production of a vector meson in an electron colliding-beam experiment is calculated in lowest-order perturbation theory. The vector meson is coupled directly to lepton pairs with coupling constant g. An approximate scheme of calculation is found in which one of the electrons is scattered at a small angle with respect to the beam direction. With reasonable experimental accuracy, a 5% determination of g is possible. (auth)

4921 NOTE ON THE STRUCTURE OF PARTICLE-MIXTURE INTERACTION. K. Fujii (Hokkaido Univ., Sapporo). Nuovo Cimento (10), 34: 722-34(Nov. 1, 1964).

The diagonalization problem of a simple particle-mixture interaction between two fermion- and boson-fields with

equal masses is considered. This problem is equivalent to that of expressing state-vectors of a field (mass m) by superposing state-vectors of another field (mass m′ ≠ m). The mathematical structure of this problem is investigated, and will be shown to be equivalent to those appearing in another theory. As the masses of primary fermion fields can be set equal to zero and then the total Lagrangian becomes invariant under a kind of Touschek transformation, it is seen that the particle-mixture theory is a very simple example of getting nonzero masses from a γ_5-invariant Lagrangian. (auth)

4922 INFLUENCE OF ABSORPTION DUE TO COMPETING PROCESSES ON PERIPHERAL REACTIONS. K. Gottfried and J. D. Jackson (CERN, Geneva). Nuovo Cimento (10), 34: 735-52(Nov. 1, 1964).

The peripheral or one-meson-exchange model is modified to include absorptive effects due to competition from other inelastic channels. These effects are most important for small impact parameters (low partial waves) and produce an appreciable reduction in cross section, and a pronounced collimation of the angular distribution. The absorption thus provides a natural explanation of the highly peaked angular distributions previously ascribed to ad hoc form factors. The necessary information concerning the absorption is inferred from the elastic scattering in the initial and final state. Because of the importance of the decay correlations of resonances produced in these reactions, the spins of the particles are treated in a consistent way. It is found that a proper treatment of the spins is also essential in evaluating the angular distribution of production. The reaction $\pi^- p \to \rho^- p$ at 4 Bev/c is discussed in detail; the theoretical cross section is in good agreement with experiment, both as to angular dependence and absolute value. The ρ meson spin-density matrix is found to be altered somewhat from the unmodified one-pion-exchange results, especially at larger production angles. The calculated density matrix is in agreement with data on the decay correlations. (auth)

4923 THE INTERMEDIATE BOSON—UNITARY TRIPLET OR OCTET? C. Ryan, S. Okubo, and R. E. Marshak (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 34: 753-8(Nov. 1, 1964). (UR-875-36)

Within the framework of unitary symmetry we discuss two possible versions of a weak intermediate vector boson theory corresponding to a triplet and an octet model, respectively. The former has the advantage that it affords the basis for a possible explanation of the large mass of the intermediate boson in terms of strong interactions but it also requires the use of the full U_3 group and not simply its SU_3 subgroup. The latter can be accommodated within the existing SU_3 octet scheme. Both versions lead to the same effective four-fermion interaction for normal weak processes but may be distinguished by observation of the production cross sections and decay modes of the intermediate bosons. (auth)

4924 PHOTONS WITHOUT PHOTONS. K. Just (Univ. of Arizona, Tucson). Nuovo Cimento (10), 34: 768-9 (Nov. 1, 1964).

The hypothesis that sourceless electromagnetic radiation cannot exist is assumed, and is extended to quantum mechanics. This extension modifies some concepts of quantum mechanics, concerning Hilbert spaces, Lorentz conditions, vacuum states, asymptotic conditions, and local invariance. (T.F.H.)

4925 GENERALIZATION OF $\mathcal{N}$-$\mathcal{N}^*_{33}$ RECIPROCAL BOOTSTRAP TO THE G_2 SYMMETRY SCHEME. P. Babu (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 34: 770-2(Nov. 1, 1964).

It is noted that it is possible to incorporate, in the G_2 symmetry scheme, the reciprocal bootstrap mechanism for the nucleon and the N^*_{33}, if the stable baryons are assigned in G_2 the 1- and 7-dimensional representations, and the $I_{\frac{1}{2}}^+$ isobars are assigned the 14-dimensional representations. In such an assignment the 1530-Mev Ξ^* resonance is required to be an isospin quadruplet. (T.F.H.)

4926 SYMMETRIES AND COMPOSITENESS. J. S. Dowker (Univ. of Manchester, Eng.). Nuovo Cimento (10), 34: 773-5(Nov. 1, 1964).

A bootstrap self-consistent calculation of the ρ meson as a composite of two pions is carried out, the only input being the usual bootstrap requirements and the assumption that the pion is itself composite. The calculation leads to isospin conservation, charge conservation, and CP invariance. (T.F.H.)

4927 QUADRATIC MASS FORMULA IN SU_3. S. Okubo and C. Ryan (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 34: 776-9(Nov. 1, 1964). (UR-875-44)

The square of the invariant mass operator for bosons and baryons is found to yield a mass formula for these particles that avoids the use of a hamiltonian that is not relativistically invariant. It is concluded that the mass formula should be evaluated in quadratic form, rather than linear form, for all particles. An explanation for the success of the linear form for baryons is proferred. (T.F.H.)

4928 DISCUSSION OF METHODS FOR THE DETERMINATION OF THE NEUTRETTO REST MASS. H. Daniel and G. Poelz (Max-Planck-Institut für Kernphysik, Heidelberg). Nuovo Cimento (10), 34: 784-7(Nov. 1, 1964).

Experiments are proposed for determining the mass of the rest mass of the neutretto. The methods described make use of energy balance in two- and three-body decay, and phase-space effects in three-body decay. (T.F.H.)

4929 STRONG INTERACTION SYMMETRIES. A. Esteve (Consejo Superior de Investigaciones Cientificas, Madrid). Nuovo Cimento (10), 34: 788-90(Nov. 1, 1964).

A group SU_3/Z is found (where Z is the center of SU_3), which has as its unitary irreducible representations the same representations as SU_3 that correspond to a Young pattern with a number of boxes equal to a multiple of three. A group of linear transformations isomorphic to SU_3/Z is found, and is shown to be locally isomorphic to SU_3, and to have as unitary irreducible representations those of SU_3 having physical significance. (T.F.H.)

4930 APPROXIMATE SOLUTION OF THE BETHE-SALPETER EQUATION FOR BOUND STATES. M. Kawaguchi (Australian National Univ., Canberra). Nuovo Cimento (10), 34: 791-4(Nov. 1, 1964).

The Bethe-Salpeter equation for bound states mediated by a finite-mass meson is discussed in the ladder approximation. The Fredholm formula is applied to find an eigenvalue of the coupling constant for a given binding energy. Difficulties concerned with divergent Fredholm traces are avoided by factorizing divergent terms, which procedure is independent of the eigenvalue problem. (T.F.H.)

4931 HIGH-ENERGY ASYMPTOTIC EXPANSION OF THE GREEN'S FUNCTION FOR FORWARD SCATTERING. N. Nakanishi (Brookhaven National Lab., Upton, N. Y.). Nuovo Cimento (10), 34: 795-8(Nov. 1, 1964). (BNL-8131)

An integral equation, of the Bethe-Salpeter type in the ladder approximation, for the Green's function of two scalar particles that exchange scalar photons is considered. The high-energy asymptotic expansion of the off-the-mass-shell scattering amplitude in the crossed channel is found, and an exactly soluble example is presented. (T.F.H.)

4932 POSSIBLE SECOND CLASS AXIAL COUPLING AND RADIATIVE MUON ABSORPTION IN LIQUID HYDROGEN. E. Borchi and R. Gatto (Università, Florence and CNEN, Frascati, Italy). Nuovo Cimento (10), 34: 807-10 (Nov. 1, 1964).

The rates for radiative μ^- capture in the muonic hydrogen molecular ion ($p\mu p$) are calculated, including a possible term in the axial current having second-class behavior under G transformation. (T.F.H.)

4933 THE CROSSING MATRIX IN ISOSPIN. C. S. Mukherjee and B. Dutta Roy (Saha Inst. of Nuclear Physics, Calcutta). Nuovo Cimento (10), 34: 811-12(Nov. 1, 1964).

It is pointed out that the crossing matrix in isospin (in the general case for two-particle scattering) can be ob-

tained in a convenient form, in terms of the Racah 6-j coefficients. (T.F.H.)

4934 SPIN OF SU_3 MULTIPLETS FROM A GENERALIZED LORENTZ GROUP. F. Paccanoni and M. Pusterla (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 34: 813-15(Nov. 1, 1964).

The principle of special relativity is broadened, in order to obtain a group that gives a unitary description of the whole system of interacting particles. This group contains the Lorentz group and SU_3, as well as other subgroups that account for photons and leptons. (T.F.H.)

4935 A METHOD OF SOLVING THE MANY-BODY K-MATRIX WITH A YUKAWA INTERACTION POTENTIAL. K. W. Wong (State Univ. of Iowa, Iowa City). Nuovo Cimento (10), 34: 816-18(Nov. 1, 1964).

A finite-series method is shown for approximately solving the many-body K matrix with a Yukawa potential. (T.F.H.)

4936 PHOTOPRODUCTION OF STRANGE PARTICLES AND UNITARY SYMMETRY. S. Hatsukade (Kyoto Univ.), L. K. Pandit, and A. H. Zimerman. Nuovo Cimento (10), 34: 819-23(Nov. 1, 1964). (UR-875-52)

The K meson coupling constant predicted by unitary symmetry considerations is much larger than that found in $K\Lambda$ photoproduction experiments on protons. It is shown that this discrepancy may possibly result from a dynamical cancellation effect in the photoproduction amplitudes, and that such a cancellation could be responsible for almost all the difference between the theoretical and experimental coupling constant values. (T.F.H.)

4937 LAMBDA–NUCLEON S WAVE INTERACTION. A. Deloff and H. W. Wyld, Jr. (Oxford Univ.). Phys. Letters, 12: 245-7(Oct. 1, 1964).

The ΛN S-wave scattering is studied using a matrix Schroedinger equation that takes account of the coupling of the ΛN and ΣN channels and the N, Λ, Σ mass differences. The potential matrix is assumed to be a central potential perfectly symmetric with respect to SU_2 transformations, and is partly determined by fitting the NN scattering. It is found that with these assumptions and physically reasonable potentials, no S-wave resonances appear in the ΛN scattering. (T.F.H.)

4938 AXIAL VECTOR MESONS. P. G. O. Freund and Y. Nambu (Univ. of Chicago). Phys. Letters, 12: 248-50 (Oct. 1, 1964).

The dominance of vector form factors by resonant vector meson states leads to the ideal that the axial-vector form factors are dominated by the axial-vector meson states. Further, the spontaneous breakdown of the "γ_5-type" SU(3) symmetry is connected to the appearance of SU(3)-octets of pseudoscalar mesons. The connection between the axial-vector mesons and the pseudoscalar mesons is explored. It is shown that axial-vector-current conservation can be used to extract information concerning the masses and coupling constants of the 1^+ meson states. (T.F.H.)

4939 SUPERCHARGED PARTICLES AND THE NEUTRINO EXPERIMENT. L. B. Okun (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Letters, 12: 250-1(Oct. 1, 1964).

It is shown that the mean hypercharge ($\langle\langle Y \rangle\rangle$) of a SU_3 supermultiplet can be expressed as a linear combination of the quantum numbers p, q, and Y^0 that characterize the supermultiplet. It is then noted that all known hadron octets and decuplets have $\langle\langle Y \rangle\rangle = 0$. It is concluded that the possibility of existence of hadrons having $\langle\langle Y \rangle\rangle \neq 0$ can be clarified by the neutrino experiment. This experiment could also shed light on the properties of such hadrons, if they exist. (T.F.H.)

4940 THE REAL PART OF THE FORWARD AMPLITUDE IN PROTON-PROTON SCATTERING AT 1.7 Gev/c. J. D. Dowell, R. J. Homer, Q. H. Khan, W. K. McFarlane, J. S. C. McKee, and A. W. O'dell (Univ. of Birmingham, Eng.). Phys. Letters, 12: 252-5(Oct. 1, 1964).

It is found, combining experimental values with theoretical expressions, that the real part (Re A(0)) of the forward scattering amplitude at a scattering angle of 0° is about $(-0.7 \pm 7)\%$ of Im A(0). It is thus concluded that Re A(0) is not large enough to account for the high value of the forward differential cross section, which must therefore result mainly from spin-dependent amplitudes. (T.F.H.)

4941 EVIDENCE FOR $\kappa(725)$ IN K^+p INTERACTIONS AT 3 Gev/c. M. Ferro-Luzzi, R. George, Y. Goldschmidt-Clermont, V. P. Henri, B. Jongejans, D. W. G. Leith, G. R. Lynch, F. Muller, and J.-M. Perreau (CERN, Geneva). Phys. Letters, 12: 255-9(Oct. 1, 1964).

The interactions of 3-Bev/c K^+ mesons with bubble-chamber protons, proceeding via $Kp \rightarrow KN3\pi$, are studied. The cross section for production of κ^+ and κ^0 in these reactions is found to be about 80 and 60 μb respectively. The properties of the κ's thus produced are analyzed. (T.F.H.)

4942 RADIATIVE CORRECTIONS TO $e^+ + e^- \rightarrow \mu^+ + \mu^-$. G. Furlan (CERN, Geneva), R. Gatto, and G. Longhi. Phys. Letters, 12: 262-5(Oct. 1, 1964).

Radiative corrections to the colliding-beam reaction $e^+ + e^- \rightarrow \mu^+ + \mu^-$ are evaluated, for energies of 0.5 to 30 Bev in the cms. The renormalization group in electrodynamics is used to obtain a tentative estimate of the higher order corrections in α. (T.F.H.)

4943 THEORETICAL AND EXPERIMENTAL RELATIONSHIP BETWEEN TRIANGLE SINGULARITIES, PEIERLS MECHANISM, AND RESONANCE POLES. C. Kacser (CERN, Geneva). Phys. Letters, 12: 269-72 (Oct. 1, 1964).

A clarification of the distinctions and similarities between the generalized Peierls mechanism and that owing to triangle singularities is presented. The conditions under which these mechanisms can be expected to be practically important are discussed. (T.F.H.)

4944 ON EXPERIMENTAL VERIFICATION OF HOMOGENEITY AND ISOTROPY OF SPACE. D. I. Blokhintsev (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 12: 272-3(Oct. 1, 1964).

Possible experiments are discussed for detecting inhomogeneities and anisotropies of space at very short distances. The role of the laboratory as an inertial system is discussed. It is noted that the negative result of the Michelson-Morley experiment could be a result of the fact that the wavelengths employed in this experiment were not short enough. (T.F.H.)

4945 2^+ OCTUPLET. M. Suzuki (Tokyo Univ.). Phys. Letters, 12: 274-5(Oct. 1, 1964).

A 2^+ octuplet meson family of SU_3 is proposed, on the basis of the $\pi\rho$ resonance around 1310 Mev. This resonance, the "R meson," decays into $\pi\eta$ as well as $K\bar{K}$. This observation restricts the quantum numbers of R. (T.F.H.)

4946 CROSS SECTION FOR THE CHARGE EXCHANGE REACTION $\pi^+ + n \rightarrow p + \pi^0$ AT 6 Gev/c PION MOMENTUM. F. Bruyant (CERN, Geneva), M. Goldberg, G. Vegni, H. Winzeler, P. Fleury, J. Huc, R. Lestienne, G. De Rosny, and R. Vanderhaghen. Phys. Letters, 12: 278-80(Oct. 1, 1964).

The cross section for the charge-exchange reaction $\pi^+ + n \rightarrow \pi^0 + p$ is estimated by analysis of the reaction $\pi^+ + d \rightarrow p + p +$ neutrals at an incident π^+ momentum of 6 Bev/c. The cross section for charge exchange is measured as 126 ± 20 μb. (T.F.H.)

4947 NEUTRINO INTERACTIONS IN THE CERN HEAVY LIQUID BUBBLE CHAMBER. M. M. Block, H. Burmeister, D. C. Cundy, et al. (CERN, Geneva). Phys. Letters, 12: 281-5(Oct. 1, 1964).

A total of 459 neutrino-induced interactions with nucleons in a freon bubble chamber is studied. The interactions analyzed include elastic events, single- and multiple-pion-production events, and strange-particle-production events. The applicability of the intermediate vector boson hypothe-

sis in these instances is discussed. The neutrino flux and total inelastic cross section are measured. (T.F.H.)

4948 PSEUDOSCALAR MESON OF MASS 960 Mev AND SYMPLECTIC EXTENSION OF SU_3 SYMMETRY. H. Bacry, J. Nuyts, and L. Van Hove (CERN, Geneva). Phys. Letters, 12: 285-7(Oct. 1, 1964).

The compatibility of a symplectic model of SU_3 with an experimentally observed $\eta\pi\pi$ resonance at 960 Mev having quantum numbers JPG = 0^{-+}, I = Y = 0 is investigated. The production and decay of 0^- mesons is also briefly discussed. (T.F.H.)

4949 THE ASYMMETRY IN THE DECAY OF THE ρ^0. J. Litvak (Comisión Nacional de Energia Atómica, Buenos Aires). Phys. Letters, 12: 287-8(Oct. 1, 1964).

A set of phase shifts including contributions of S-, P-, and D-waves is found for the angular distributions of the $\pi^+\pi^-$ pair from decay of the ρ^0 meson. The phase shifts are based on experimental data on the interaction $\pi^- + p \rightarrow n + \rho^0 \rightarrow n + \pi^+ + \pi^-$. (T.F.H.)

4950 VERTEX EFFECTS IN MANY-FERMION SYSTEMS. A. J. Layzer (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Letters, 13: 121-3(Nov. 15, 1964).

The vertex function of the quasi-particle in an arbitrary spin-independent and rotationally invariant two-body interaction was investigated in both perturbative and non-perturbative approaches. (D.C.W.)

4951 ON SOME CONSEQUENCES OF BOHR'S SYMMETRY. S. M. Bilenkii and R. M. Ryndin (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 13: 159-61(Nov. 15, 1964).

Relations between expectation values of certain spherical spin tensors in the general case of the reaction a + b → c + d are obtained, resulting from invariance under a reflection in the reaction plane and containing (in addition to the observables) only the spins and intrinsic parities of the particles involved. (D.C.W.)

4952 A POSSIBLE MECHANISM FOR THE P_{11} PION NUCLEON RESONANCE. C. R. Hagen (Imperial Coll. of Science and Tech., London and Univ. of Rochester, N. Y.). Phys. Letters, 13: 165-7(Nov. 15, 1964).

The P_{11} π-N resonance around 1500 Mev was investigated in terms of a tendency for a stable particle to induce a high-energy resonance of the same quantum numbers for a sufficiently strong coupling. (D.C.W.)

4953 ON THE RATIO BETWEEN $\Delta S = -\Delta Q$ AND $\Delta S = 2$ DECAY AMPLITUDES. D. Horn (Tel-Aviv Univ., Israel). Phys. Letters, 13: 171-2(Nov. 15, 1964).

The magnitude of the $\Delta S = 2$ amplitude was investigated, using an extension of Cabibbo's theory and recent observations on the branching ratio for $\Sigma^+ \rightarrow n + e^+ + \nu_e$. (D.C.W.)

4954 AN UNSUCCESSFUL SEARCH FOR HYPER-STRANGE MESONS WITH MASSES BETWEEN 640 AND 940 Mev. A. Boserup (Univ. of Copenhagen). Phys. Letters, 13: 172-3(Nov. 15, 1964).

An attempt was made to detect the charmed mesons (C) predicted for the meson octets of SU_3 by observing the process $\bar{p} + p \rightarrow C + \bar{C} \rightarrow K^0 + \pi^+ + \pi^- + \pi^0$. No evidence for production of charmed mesons was obtained. (D.C.W.)

4955 PHASE SHIFT ANALYSIS OF THE π^+p ELASTIC SCATTERING AT 240 Mev. I. M. Ivanchenko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.) and V. A. Schegelskii. Phys. Letters, 13: 174(Nov. 15, 1964).

Data on elastic π^+-p scattering at 240 Mev were analyzed under the assumptions that S, P, and D waves are involved or that only S and P waves are involved. The best fit was provided by an SPD solution. (D.C.W.)

4956 A CONNECTION BETWEEN THE RATIO Re A(s,0)/Im A(s,0) AND THE HIGH-ENERGY PION-NUCLEON TOTAL CROSS SECTIONS. P. Olesen (Universitetets Institut for Teoretisk Fysik, Copenhagen). Phys. Letters, 13: 175-7(Nov. 13, 1964).

It is shown that if the ratio is taken to be constant for $\pi^{\pm}$-p interactions at high energy, the total cross sections vanish in the high-energy limit. (D.C.W.)

4957 THE EXACT DETERMINATION OF COUPLING CONSTANTS IN TERMS OF MASSES FROM UNITARITY AND ANALYTICITY. A. O. Barut and T. Sawada (Univ. of Colorado, Boulder). Phys. Letters, 13: 177-80(Nov. 15, 1964).

A method for obtaining coupling constants in terms of masses, on the basis of analyticity and unitarity considerations, is described. (D.C.W.)

4958 SOME CONSEQUENCES OF HIGHER SYMMETRY GROUP W_3 WITH PARITY INTERCHANGE. R. E. Marshak, N. Mukunda, and S. Okubo (Univ. of Rochester, N. Y.). Phys. Letters, 13: 180-2(Nov. 15, 1964).

Mass relations for spin-zero and spin-one mesons are presented, following from broken $\overline{W}_3$(or $S\overline{W}_3$) symmetry under various assumptions concerning the tensorial behavior of the symmetry-breaking terms and the particle representations. (D.C.W.)

4959 MACH'S PRINCIPLE AND THE APPARENT BREAKDOWN OF CP INVARIANCE IN K MESON DECAYS. D. W. Sciama (Cambridge Univ., Eng.). Phys. Letters, 13: 182(Nov. 15, 1964).

The apparent breakdown of CP invariance in meson (K) decays was recently attributed to a long-range interaction between mesons (K) and distant matter, the potential being due mainly to material in the Milky Way. It is shown that if the potential is of sufficiently long range and if most of the material in the universe is matter rather than anti-matter, the coupling constant of the interaction would be much smaller than originally predicted, making detection of the interaction by Eotvon-type experiments very difficult. (D.C.W.)

4960 INELASTIC ELECTRON-DEUTERON SCATTERING: REMARK ON A NOTE OF HOLZL AND URBAN. L. Durand (Yale Univ., New Haven). Phys. Letters, 13: 184-5(Nov. 15, 1964).

A theoretical expression for the inelastic scattering cross section at the quasi-elastic peak is considered, particularly a factor in the expression that was previously evaluated by Holzl and Urban. A corrected value for the factor is given. (D.C.W.)

4961 A SINGULAR BOUNDARY CONDITION FOR THE P_{33} PION-NUCLEON STATE. K. C. Jacobs and E. L. Lomon (Massachusetts Inst. of Tech., Cambridge). Phys. Letters, 13: 188-90(Nov. 15, 1964). (MIT-2098-85)

The energy dependence of the logarithmic derivative of the wave function at the boundary radius was determined for several choices of the boundary radius, starting from the asymptotic amplitude in the P_{33} state to 700 Mev. A pole was observed for a physically plausible range of the boundary radius. The energy dependence was described well by a single-pole formula over most of the 700-Mev range. (D.C.W.)

4962 UNIVERSALITY OF TRANSVERSE MOMENTUM DISTRIBUTIONS IN HIGH ENERGY PHYSICS. J. Orear (CERN, Geneva). Phys. Letters, 13: 190-2(Nov. 15, 1964).

Experimental data on the angle and energy distributions of both elastic and inelastic interactions at high momentum transfers, including p-p, π-p, and e-p processes, are reviewed. It is concluded that the dominant feature of the distributions is a simple exponential dependence in transverse momentum. (D.C.W.)

4963 ELASTIC d-d SCATTERING AT 64 Mev. N. M. Queen (Univ. of Birmingham, Eng.). Phys. Letters, 13: 236-8(Dec. 1, 1964).

A multiple scattering expansion is used to analyze a simple four-body problem, namely elastic d-d scattering at 64 Mev. The incident deuteron is treated as a single particle and the target deuteron as an n-p composite system, so that the problem becomes analogous to three-body processes. The differential cross section is calculated and compared with experimental results. (C.E.S.)

4964 SCATTERING MATRIX ELEMENTS IN THE RELATIVISTIC THREE-BODY PROBLEM. V. P. Shelest and D. Stoyanov (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 13: 253-5(Dec. 1, 1964).

Expressions are derived for the matrix elements describing all possible three-particle processes except for those involving the three-particle bound states. Transition operators are introduced whose matrix elements determined in a certain way coincide with the corresponding matrix elements of the T-matrix. Some relations among these operators were obtained. (C.E.S.)

4965 SPONTANEOUS SYMMETRY BREAKDOWN IN μ–e ELECTRODYNAMICS. R. Arnowitt (Northwestern Univ., Boston) and S. Deser. Phys. Letters, 13: 256-8 (Dec. 1, 1964).

The possibility of spontaneous symmetry breakdowns in the electrodynamics of two originally identical charged fields (meson (μ) and electron fields) with minimal coupling is examined. Aside from its application to the system in question, the analysis provides a simple example of an internal symmetry, i.e., SU(2), which can be either partially or totally broken. Only minimal gauge invariant interactions are involved, and hence divergences and cut off problems are avoided, at least in the approximation used. (C.E.S.)

4966 A SEARCH FOR NEUTRINOLESS DECAY MODES OF THE NEGATIVE MUON. J. H. Bartley, H. Davies, H. Muirhead, and T. Woodhead (Univ. of Liverpool). Phys. Letters, 13: 258-9(Dec. 1, 1964).

An experiment was performed to search for the processes $\mu^- + Cu \rightarrow Cu + e^-$ and $\mu^- + Cu \rightarrow Cu + e^- + \gamma$. No event satisfying the criteria for either reaction was found. From the number of mesons (μ^-) stopped, the overall detection efficiencies, and the absence of events branching ratios of less than 2.2×10^{-7} and 7.8×10^{-7}, respectively, each with 90% confidence, are determined. The results are interpreted as an absence of neutral currents in strangeness-conserving weak interactions. (C.E.S.)

4967 A DYNAMICAL SCHEME OF MESON SUPERMULTIPLETS, POSSIBLE ASSIGNMENTS, AND BRONZAN-LOW [1] QUANTUM NUMBERS. Hong-mo Chan and C. Wilkin (CERN, Geneva). Phys. Letters, 13: 263-5 (Dec. 1, 1964).

An attempt is made to fit the mesonic resonances reported to-date into a scheme suggested by a dynamical model. It is found that all reasonably well-established enhancements fit comfortably into the scheme except for the $I_z = 3/2$ enhancement at 1270 Mev. A suggestion of Bronzan and Low for a new empirical quantum number is taken up and tentative assignments are made to new resonances. The resulting list shows some remarkable regularities. Decay modes of further resonances suggested by the scheme are listed. (C.E.S.)

4968 EVIDENCE FOR ENERGY DEPENDENCE OF PHOTON-NUCLEON CROSS SECTION FROM COSMIC-RAY EXPERIMENTS. H. S. Murdoch and H. D. Rathgeber (Univ. of Sydney). Phys. Letters, 13: 267-9(Dec. 1, 1964).

Cosmic-ray data that favor a total photon-nucleon cross section that decreases above a few Bev as $E^{-\alpha}$ where α is close to unity are discussed. (C.E.S.)

4969 ON THE SUPERPOSITION PRINCIPLE AND CP INVARIANCE IN K^0 DECAY. B. Laurent (NORDITA, Copenhagen and Univ. of Stockholm) and M. Roos. Phys. Letters, 13: 269-70(Dec. 1, 1964).

An experiment on meson (K^0) decay which seems to indicate that CP invariance is violated is considered. It is suggested that the quantum mechanical superposition principle be carefully examined in the case of meson (K^0) decay. It is shown that a CP invariant but nonlinear theory can give results in agreement with experiment. (C.E.S.)

4970 SU(3) AND SU(4) RELATIONS IN ANTIPROTON-NUCLEON ANNIHILATION. Michael Parkinson (Univ. of Chicago). Phys. Rev. Letters, 13: 588-90(Nov. 16, 1964).

The general case of antiproton-nucleon annihilation into vector plus pseudoscalar mesons is considered by means of the SU(3) and SU(4) symmetry relations. The relative amplitudes and branching ratios are calculated for both $\bar{p}$-n and $\bar{p}$-p annihilation. (C.E.S.)

4971 HIGHER SYMMETRIES AND STRANGE-PARTICLE PRODUCTION. Harry J. Lipkin (Argonne National Lab., Ill.). Phys. Rev. Letters, 13: 590-2 (Nov. 16, 1964).

The rapid decrease in cross section with increasing strangeness of the particles (N,Λ,Ξ,Ω) produced seems to indicate the existence of a selection rule. Any proposed higher symmetry should have fewer free parameters and may be restricted so much that it must either exhibit a selection rule or disagree with experiment. It is pointed out that a selection rule may be obtained from higher symmetry schemes which are extensions of the Wigner supermultiplet classification. A quark model is used as the simplest method of presentation, but it is not necessary to obtain the result. (C.E.S.)

4972 SHELL MODEL OF BARYONS. Peter G. O. Freund and Benjamin W. Lee (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 13: 592-5(Nov. 16, 1964).

Implications of the hypotheses that baryons are built up of spin-$\frac{1}{2}$ fermions belonging to a unitary triplet (called baryonettes); within a baryon, these baryonettes move in a self-consistent central field, exhibiting a shell structure; coupled spin-unitary-spin symmetry is not an intrinsic symmetry of the fundamental lagrangian, but a symmetry of the baryon wave function (in terms of baryonette coordinates) in the central-field approximation are investigated. This symmetry is broken by the residual interaction between baryonettes which is not accounted for by the central field. The basic triplet will be assumed to have the charge structure ($\frac{1}{3}$,$-\frac{1}{3}$,$-\frac{1}{3}$) just as quarks. Both LS- and jj-coupling shell models of baryons are discussed. (C.E.S.)

4973 EXACT BOOTSTRAPS IN SOME STATIC MODELS. Kerson Huang and Francis E. Low (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 13: 596-8(Nov. 16, 1964). (MIT-2098-73)

The known solutions of some exactly soluble siatic models of meson-baryon scattering (neutral, charged, symmetric scalar, and neutral pseudoscalar theories in the one-meson approximation) were investigated to determine whether any of them possesses bootstrap solutions. For all of these models no bootstrap solutions exist that satisfy unsubtracted dispersion relations. Bootstrap solutions do exist that satisfy subtracted dispersion relations. A subtraction can only be made if a cutoff function is also introduced. (C.E.S.)

4974 SPIN AND UNITARY-SPIN INDEPENDENCE IN A PARAQUARK MODEL OF BARYONS AND MESONS. O. W. Greenberg (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 13: 598-602(Nov. 16, 1964).

A brief defense of the possibility that quarks are para-Fermi is presented, and the classification of baryon states in the paraquark model is discussed. (C.E.S.)

4975 ELECTROMAGNETIC STRUCTURE OF THE NEUTRON AND PROTON. J. R. Dunning, Jr., K. W. Chen, A. A. Cone, G. Hartwig, N. F. Ramsey, J. K. Walker, and Richard Wilson (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 13: 631-5(Nov. 23, 1964).

The quasielastic scattering of electrons by deuterons and the elastic scattering of electrons by protons were observed. The form factors of the neutron were determined for four-momentum transfers of 10 to 175 F^{-2}, together with some additional values for the proton form factors. The form factors are compared with previous determinations. (D.C.W.)

4976 GAMMA-RAY PROTON INTERACTIONS BETWEEN 0.5 AND 4.8 Bev. H. R. Crouch, Jr. (Brown Univ., Providence), R. Hargraves, B. Kendall, et al. Phys. Rev. Letters, 13: 636-9(Nov. 23, 1964). (MIT-2098-71)

The production of hyperons and mesons in interactions of photons with protons at 0.5 to 4.8 Bev was investigated. Cross sections were obtained, and the strange-particle events were studied in detail. (D.C.W.)

4977 $N^*_{33}(1238)$ AND ρ^0 PRODUCTION BY HIGH-ENERGY PHOTONS. H. R. Crouch, Jr. (Brown Univ., Providence), R. Hargraves, B. Kendall, et al. Phys. Rev. Letters, 13: 640-3(Nov. 23, 1964). (MIT-2098-72)

The mechanism of the interaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$ was studied on the basis of the observations reported in the previous paper, with particular consideration of production of the 1238-Mev π-N isobar and the meson (ρ^0). (D.C.W.)

4978 ELECTROMAGNETIC PROPERTIES OF BARYONS IN THE SUPERMULTIPLET SCHEME OF ELEMENTARY PARTICLES. Bunji Sakita (Argonne National Lab., Ill.). Phys. Rev. Letters, 13: 643-6(Nov. 23, 1964).

The electromagnetic properties of baryons are discussed under the assumptions that the electric (and magnetic) current is a tensor of the regular representation of SU(6) and also of the (1,8)- and (3,8)-representation of SU(2) ⊗ SU(3) and that the representation for baryons is 56. The mass differences among the states in an isomultiplet are also discussed under the assumption that they are due to a second-order electromagnetic perturbation. (D.C.W.)

4979 ISOTOPIC STRUCTURE OF THE WEAK INTERACTIONS. V. De Santis (Northwestern Univ., Evanston, Ill.). Phys. Rev. Letters, 13: 646-9(Nov. 23, 1964).

A model is proposed in which the regularities shown by the weak interactions are attributed to the existence and conservation of a weak isotopic spin and its third component, which is related to the electric charge through the leptonic charge. Conservation of lepton and baryon numbers, as well as charge, is assumed. The quantum numbers proposed for the leptons and the meson and baryon octet are tabulated. (D.C.W.)

4980 EXAMPLE OF DECAY $\Omega^- \rightarrow \Xi^- + \pi^0$. G. S. Abrams (Univ. of Maryland, College Park), R. A. Burnstein, G. R. Charlton, et al. Phys. Rev. Letters, 13: 670-2(Nov. 30, 1964).

A hydrogen bubble chamber was exposed to a mass-separated beam of 4.2-Bev/c mesons (K^-), and events interpreted to be $K^- + p \rightarrow \Omega^- + K^+ + K^0$, $\Omega^- \rightarrow \Xi^- + \pi^0$ are discussed. (C.E.S.)

4981 N^* PRODUCTION BY NEUTRINOS. Carl H. Albright and Lu Sun Liu (Northwestern Univ., Evanston, Ill.). Phys. Rev. Letters, 13: 673-6(Nov. 30, 1964).

The direct N^*-production process $\nu_l\ (\bar{\nu}_l) + N \rightarrow l(\bar{l}) + N^*$ is investigated. If a local V-A interaction is assumed for the leptons, the dynamics of this reaction is entirely contained in the N-N^* transition vertex. Feynman diagrams for N^* production by neutrinos show some of the intermediate states contributing to the vertex function and show that Landau singularities will be encountered in a dynamical calculation. The analysis of the subsequent decay, $N^* \rightarrow N + \pi$, reveal the nature of the vertex functions involved. (C.E.S.)

4982 ANALYTICITY OF THE ABSORPTIVE PART OF THE SCATTERING AMPLITUDE. Noboru Nakanishi (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 13: 677-8(Nov. 30, 1964). (BNL-8529)

It is shown that the assumption that the absorptive part of the scattering amplitude, A(s,t), is holomorphic inside an ellipse with foci $t = 0$ and $t = -(S - 4\mu^2)$ and with semi-major axis $\frac{1}{2}(S + 4\mu^2)$ in the t plane is valid in every order of perturbation theory. Here S and t are the invariant squares of energy and momentum transfer. Spinless particles having mass μ only are considered, and the absence of one-particle intermediate states in the t channel is assumed. (C.E.S.)

4983 GROUP U(6) ⊗ U(6) GENERATED BY CURRENT COMPONENTS. R. P. Feynman, M. Gell-Mann, and G. Zweig (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 13: 678-80(Nov. 30, 1964).

It was previously suggested that the equal-time commutation rules of the time component of the vector and axial-vector current octets ($F_{i\alpha}$ and $F^5_{i\alpha}$, respectively) are the same as if these currents had the simple form $G_{i\alpha}$ and $G^5_{i\alpha}$, defined as $G_{i\alpha} = \frac{1}{2}i\bar{q}\lambda_i\gamma_\alpha q$, and $G^5_{i\alpha} = \frac{1}{2}i\bar{q}\lambda_i\gamma_\alpha\gamma_5 q$, where q is an SU(3) triplet with spin $\frac{1}{2}$, for example, the quarks or aces. Here the matrices $\lambda_i (i = 1, \ldots, 8)$ are the SU(3) analogs of the Pauli matrices. The operators $F_i(t) = -i\int d^3 \times F_{i4}$, and $F^5_i(t) = -i\int d^3 \times F^5_{i4}$, then generate at equal times the algebra of SU(3) ⊗ SU(3), which may be a very approximate symmetry of the strong interactions, while F_i generate a subalgebra corresponding to SU(3), which is a fairly good symmetry of the strong interactions. These considerations are extended to the space components of the currents. A ninth λ matrix, $\lambda_0 \equiv (\frac{2}{3})^{\frac{1}{2}} 1$ and a corresponding ninth pair of currents $F_{0\alpha}$ and $F^5_{0\alpha}$ (where $F_{0\alpha}$ would be $\sqrt{6}$ times the baryon current in a true quark or ace theory) are defined. It is assumed that the equal-time commutation relations of all the 72 components of the $F_{i\alpha}$ and $F^5_{i\alpha}$ ($i = 0, \ldots, 8$) are the same as those of the $G_{i\alpha}$ and $G^5_{i\alpha}$, at least as far as terms proportional to the spatial δ function are concerned. The system $G_{i\alpha}$ and $G^5_{i\alpha}$ is closed under equal-time commutation, and the space integrals $\int G_{i\alpha} d^3 x$ and $\int G^5_{i\alpha} d^3 x$ generate the algebra of U(6) ⊗ U(6). The assumption thus implies that $\int G_{i\alpha} d^3 x$ and $\int F^5_{i\alpha} d^3 x$ also generate the algebra of U(6) ⊗ U(6). It is assumed that this algebra is a very approximate symmetry of the strong interactions. Some of the structure of the algebra is exhibited. (C.E.S.)

4984 TEST FOR THE BORN-APPROXIMATION MODEL OF THE PEIERLS MECHANISM. Ching-hung Woo (Stanford Univ., Calif. and Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 13: 696-8(Dec. 7, 1964).

A test based on meson-baryon scattering phenomena is proposed for the Born-approximation model of the Peierls mechanism. (C.E.S.)

4985 INTRINSICALLY BROKEN U(6) ⊗ U(6) SYMMETRY FOR STRONG INTERACTIONS. K. Bardakci, J. M. Cornwall, P. G. O. Freund, and B. W. Lee (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 13: 698-701(Dec. 7, 1964).

A chain of symmetries culminating in $W_8 \equiv U(6) \otimes U(6)$ is produced. In contradistinction to symmetries previously considered in physics, the largest members of this chain are intrinsically broken. In other words, there does not exist a total lagrangian that possesses W_8 symmetry, since the kinetic energy and mass terms will automatically break it. The symmetry will show up only in the interaction term and will consequently make sense in terms of a strong-coupling limit. (C.E.S.)

4986 ONE BOSON EXCHANGE MODEL IN NUCLEON-NUCLEON SCATTERING. [PART] II. Shoji Sawada (Hiroshima Univ.), Tamotsu Ueda, Wataro Watari, et al. Progr. Theoret. Phys. (Kyoto), 32: 380-98(Sept. 1964).

A model for strong interaction was previously proposed, according to which the N-N scattering should be explained in terms of the superposed contribution of one-boson exchange. It was shown that the p-p scattering can be well interpreted with the contribution of the pion, scalar boson ($m_s = 4m_\pi$) and vector boson ($m_v = 4m_\pi$). It is shown that both p-p scattering and n-p scattering can be explained except for the S-wave, in terms of the observed mesons — meson (ρ), meson (ω) and meson (n) — and the I = 0 scalar meson with mass 500 ~ 700 Mev. The coupling constants of meson (ρ) and meson (ω) are determined. The allowed upper limit of the coupling constant of meson (n) is obtained. (auth)

4987 BOSON LEVELS AND COMPOSITE MODEL. [PART] II. Shin-yu Furui (Ibaraki Univ., Mito, Japan), Susumu Furuichi, Shin Ishida, et al. Progr. Theoret. Phys. (Kyoto), 32: 399-405(Sept. 1964).

Boson levels were previously investigated dynamically from the viewpoint of the symmetrical Sakata model. Application of the method to the nuclear force problem led to

the existence of a di-nucleon (N-N bound state in the I = 0 $^3S_1$ state) with a rather light mass ≈ 1 Bev. The possibility of improving this situation is investigated. (P.C.W.)

4988 ON THE MASS OF THE PSEUDOSCALAR MESON IN NAMBU'S MODEL. Masao Yamada (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 406-10(Sept. 1964).

The mass of the pseudoscalar meson in Nambu's model is calculated. The principle of the approximation is that the arguments concerning the mass of the meson must include the possible effective four-boson interactions. It is shown that a pseudoscalar meson of non-zero mass is generated dynamically in the model. (auth)

4989 U(4) SYMMETRY IN STRONG INTERACTIONS AND RELATING MASS FORMULA. Mitsuru Hama (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 411-17(Sept. 1964).

The mass levels of baryons and bosons are investigated, assuming U(4) symmetry and introducing a fourth fundamental fermion Λ_6' in addition to the three fundamental fermions p_6, n_6, and Λ_6. The mass splitting interactions are assumed to be of the form $\bar{\Lambda}_6'-\Lambda_6'$ in addition to $\bar{\Lambda}_6-\Lambda_6$. (D.C.W.)

4990 MASS SPECTRA OF PARTICLES AND MODEL OF THE STRONG INTERACTIONS. Seitaro Nakamura (Tokyo Univ. and Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 418-37(Sept. 1964).

A mass formula is introduced by which the observed pattern of baryons, as well as that of mesons can be reproduced. By assuming that particles with spin 0 and ½ correspond to the components in the isotopic-spin space ($S(U_2)$ × $S(U_3)$) as well as in the "hyperspin" space (R_3 or $S(U_2)$ × $S(U_2)$) — hyperspin U is a vector, the third component of which is hypercharge —, baryons are arranged into a triplet (N, Λ, Ξ) and a singlet (Σ); and mesons are arranged into a triplet (K, η, $\bar{K}$) and a singlet (π) in hyperspin space. Also by assuming that hyperspin should be independent of isotopic-spin and the pattern of particles as components of these two "spins" should be complete, fictitious baryons X^0X^-, $Y^+Y^0Y^-$, Z^+Z^0, V^0 are introduced, which are complementary to baryons: pn, Λ, $\Xi^0\Xi^-$, $\Sigma^+\Sigma^0\Sigma^-$ as well as fictitious mesons L^0L^-, $D^+D^0D^-$, $\bar{L}^+\bar{L}^0$, $\pi^{0\prime}$ which are complementary to mesons K^+K^0, η, $\bar{K}^0\bar{K}^-$, $\pi^+\pi^0\pi^-$, respectively. The interaction Hamiltonian among baryons and mesons is formulated, which is rotationally invariant in hyperspin space as well as in isotopic spin space. If the parity of fictitious particles is opposite to that of observed particles, the higher symmetry would be violated. The possible effects on the reactions as well as on the mass splitting are briefly discussed. (auth)

4991 ON THE 2^- DECUPLET BOSONS. Hirotaka Sugawara (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 465-6(Sept. 1964).

The consequences of the assignment of the 2^- bosons to the $10 + 10^*$ representation of SU_3 are considered. It is concluded that the I = ³/₂ particle has a mass of 1230 Mev. Mass relations, decay modes, and production processes are considered. (D.C.W.)

4992 REMARKS ON DESCRIPTION OF THE A(1090 Mev) AND X^0(960 Mev) MESONS IN THE SU_3 SCHEME. Shigeo Minami (Louisiana State Univ., Baton Rouge). Progr. Theoret. Phys. (Kyoto), 32: 467-8(Sept. 1964).

A model in which the mesons (A) and (X^0) belong to a pseudoscalar-meson octet is proposed. A resonance in the K-π-η system with I = ½ and with a mass of about 993 Mev is predicted by the model. Experimental tests of the model are briefly considered, together with the properties of the meson (A).

4993 PHASE SHIFTS STATISTICAL DESCRIPTION OF ELASTICALLY SCATTERED SPIN PARTICLES. I. Brandus (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 235-43(1964).

The density matrix of the spin states of particles with arbitrary spin, scattered elastically by spinless targets, is expressed using a scattering matrix obtained previously. A series expansion of the density matrix with respect to an appropriate complete system of matrices in spin space is derived. Using the expansion, the expectation values of all corresponding irreducible spin tensors (Fano's tensors) are calculated in terms of phase shifts. The resultant formulas permit the calculation of any physical quantity relative to the spin states of the scattered particles. As an example, the elastic scattering of spin–3/2 particles is considered. (auth)

4994 ON THE RADIATIVE DECAYS OF VECTOR MESONS. Li-ning Chang. Wu Li Hsueh Pao, 20: 814-16 (Aug. 1964). (In Chinese)

4995 ON THE DECAYS OF Λ AND Σ HYPERONS. Guo-zheng Yang. Wu Li Hsueh Pao, 20: 819-21(Aug. 1964). (In Chinese)

4996 DETERMINATION OF THE πN CHARGE EXCHANGE SCATTERING AMPLITUDE FROM THE EXPERIMENTAL DATA AT HIGH ENERGIES. G. Hoehler and N. Zovko (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 181: 293-300(1964).

The difference between the π^+-p and π^--p diffraction peaks is used to estimate the imaginary part of the charge exchange scattering amplitude. The imaginary part has a narrow peak in the forward direction and passes over to negative values at a momentum transfer t of about −0.15 $(Bev/c)^2$. If the charge exchange amplitude is dominated by the contribution of the ρ Regge pole, the peak is mainly due to the t-dependence of the residue function and a narrow forward peak is expected in the charge exchange angular distribution. (auth)

4997 CONSISTENCY OF NEW πN PHASE-SHIFT ANALYSES WITH DISPERSION RELATIONS. Rolf Hueper (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 181: 426-35(1964).

Phase-shift analyses for π-N scattering are used to check the dispersion relations for the amplitudes $B_4(\nu_L, 0)$, which are essentially determined by the π-N spin-flip scattering extrapolated to the forward direction. Within the experimental errors, the relations seem to be fulfilled. The π-N coupling constant f^2 turns out to be consistent with the value found by Hamilton and Woolcock (0.081 ± 0.003). However, in spite of the newer data and reduced sensitivity of the calculational procedure toward the high-energy behavior of the amplitudes, the error of f^2 is still considered to be somewhat large. Some information on the high-energy behavior of the spin-flip amplitudes was also obtained. (auth)

4998 EFFECT OF LOGARITHMIC SINGULARITIES ON PARAMETERS OF SEVERAL RESONANCES. V. V. Anisovich. A. N. Moskalev, and V. V. Fomin (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 771-3(Aug. 1964). (In Russian)

Interactions in which three particles are produced, a single particle and a resonance decaying into two particles, one of which interacts with the single particle, are considered. The effects of logarithmic singularities in such interactions on the parameters of resonances in the $\rho\pi$ (A resonance), $\omega\pi$ (B resonance), and $\Sigma\pi$ (Λ_{1405} or Y_0^* resonance) systems are studied, using previous experimental results. (M.J.T.)

4999 MEASUREMENT OF THE SPIN CORRELATION COEFFICIENTS IN ELASTIC pp SCATTERING AT 315 Mev. Yu. M. Kazarinov, F. Legar, G. Peter, A. F. Pisarev, and K. M. Falbrukh (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 47: 848-54(Sept. 1964). (In Russian)

The spin correlation coefficients in elastic pp scattering are measured by the spark chamber technique at energies of 315 Mev and an angle of 45° in the cms. The results are $C_{nn} = +0.90 \pm 0.51$ and $C_{kp} = +0.74 \pm 0.51$. A phase shift analysis of pp scattering at 310 Mev is performed with aid of these data. It is shown that the existence of the first set of phase shifts previously found is more probable than that of the second set. (auth)

5000 ANALYTIC PROPERTIES OF THE SCATTERING MATRIX FOR A NONLOCAL SEPARABLE POTENTIAL. A. V. Rokhlenko. Zh. Eksperim. i Teor. Fiz., 47: 896-901(Sept. 1964). (In Russian)

The analytical properties of the S matrix for a very extensive class of nonlocal separable potentials are investigated in detail in the nonrelativistic approximation. The existence of poles of partial amplitudes of the S matrix in the lower semi-plane of the energy variable k is proved in a certain particular case. (auth)

5001 FERMION MASS IN NONLINEAR THEORY. A. I. Naumov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 914-17(Sept. 1964). (In Russian)

An attempt is made to calculate the mass of the ground fermion (nucleon) within the framework of the Heisenberg variant of a unified nonlinear theory of elementary particles by taking into account the relation between the spiral properties of particles and their masses. It is found that the possibility of degeneracy of the vacuum of a system of interacting fields with respect to some quantum numbers must be taken into account. (auth)

5002 ON THE APPLICABILITY OF PARASTATISTICS TO ELEMENTARY PARTICLES. A. Ts. Amatuni (Inst. of Physics, Erevan). Zh. Eksperim. i Teor. Fiz., 47: 925-9 (Sept. 1964). (In Russian)

The rules for calculating various electrodynamic effects for a system of parafermions and photons are derived. In contrast to the early work of Volkov the analysis is based on the Green transformation; as a result the formal apparatus of quantum electrodynamics of parafermions is reduced to the usual one and any possible differences are easily comprehensible. Comparison of the formulas for photoproduction of parafermions with the experimental results of the Fraskati group on photoproduction of mesons (μ) indicates that the meson (μ) is an ordinary fermion. Furthermore, application of the causality principle to the lagrangians of weak interactions showed that there are neither parafermions nor parabosons among the well known elementary particles. (auth)

5003 QUANTUM PROCESSES IN THE FIELD OF A CIRCULARLY POLARIZED ELECTROMAGNETIC WAVE. N. B. Narozhnyi, A. I. Nikishov, and V. I. Ritus (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 930-40(Sept. 1964). (In Russian)

The effect of the field of a circularly polarized electromagnetic wave of arbitrary intensity on various quantum processes is considered. The probability and intensity of photon emission by an electron, the probability for pair production by a photon and the probability for $\pi \to \mu + \nu$ decay in the field of the wave are obtained. The expressions for the probabilities are simpler than those for a linearly polarized wave and permit one to investigate in detail the intermediate region lying between the domain of perturbation theory and the constant field region. A study of this intermediate region yields, in particular, information of a qualitative nature on the effect of an inhomogeneous field on the processes. The dependence of the probabilities on wave frequency for a given field strength and the distribution in number of photons absorbed from the field are considered in detail. (auth)

5004 NEUTRINO PAIR PRODUCTION IN ELECTRON DIPOLE TRANSITIONS. V. M. Ermachenko and V. P. Kopyshev. Zh. Eksperim. i Teor. Fiz., 47: 958-9(Sept. 1964). (In Russian)

A general formula is deduced for the energy losses of a nonrelativistic electron due to emission of a neutrino pair. The energy losses are proportional to the square of the dipole moment, just as in electrodynamics. The results obtained by Gandelman and Pinaev are correspondingly corrected. (auth)

5005 GAUGE INVARIANCE AND THE PHOTON MASS. A. I. Vainshtein, V. V. Sokolov, and I. B. Khriplovich (Novosibirsk State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 47: 1003-6(Sept. 1964). (In Russian)

Although gauge invariance of the electromagnetic interaction is consistent with a nonvanishing bare mass of the photon, it nevertheless leads to the equality $\Pi(0) = 0$ if the Ward differential identity is satisfied. The conditions under which the physical mass of the photon should vanish are discussed. (auth)

5006 ON THE ASYMPTOTIC RELATIONS BETWEEN CROSS SECTIONS IN THE CASE WHEN ELECTROMAGNETIC INTERACTION IS TAKEN INTO ACCOUNT. L. D. Solovev (Joint Inst. of Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1043-9(Sept. 1964). (In Russian)

It is shown that on taking into account strong and electromagnetic interactions, the ratio of the scattering differential cross sections for particles and antiparticles tends to unity providing the cross sections are measured with an equal and sufficiently high energy resolutions. With respect to the behavior of the amplitudes at high energies, the same assumption is made as that employed in an analysis of the strong interaction. (auth)

5007 ON SPIN AND ANGULAR CORRELATIONS IN NEUTRINO-LEPTON INTEKACTIONS. B. K. Kerimov and Yu. I. Romanov (Inst. of Medical Radiology, Academy of Medical Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1123-9(Sept. 1964). (In Russian)

Scattering of neutrinos and antineutrinos on free electrons (muons) is investigated in the first approximation of perturbation theory with respect to four-fermion (V,A) interaction by taking into account spin correlations. The neutrino is described by a four-component Dirac spinor. It is shown that study of neutrino (antineutrino) scattering on polarized electrons (muons) and also of longitudinal polarization of recoil electrons (muons) in νe and $\nu\mu$ scattering should permit one to distinguish between the two types of neutrino and antineutrino (electron and muon) and also to solve the problem of the existence of direct νe and $\nu\mu$ interaction. (auth)

5008 NONLINEAR EFFECTS IN COMPTON SCATTERING AND PAIR PRODUCTION DUE TO ABSORPTION OF SEVERAL QUANTA. A. I. Nikishov and V. I. Ritus (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1130-3(Sept. 1964). (In Russian)

Effects in Compton scattering and pair production which are nonlinear with respect to photon density and are due to absorption of several photons are discussed. The probabilities of the effects are presented. Calculation of multiphoton absorption effects by perturbation theory encounters a difficulty connected with the electron propagation function becoming infinite. Removal of this difficulty is discussed. (auth)

5009 ELECTROMAGNETIC PROPERTIES OF STRONGLY INTERACTING PARTICLES IN THE UNITARY MODEL. A. I. Akhiezer and M. P. Rekalo (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1169-71(Sept. 1964). (In Russian)

The concepts of U spin and U multiplets are used to allow a very simple estimation of the electromagnetic interaction H_{em} to any order and the interaction H_b, breaking unitary symmetry, to the first order of perturbation theory. By generalizing the results of Okubo, it is shown that mass splitting and various electromagnetic parameters (magnetic moments, form factors, Compton-effect amplitudes) satisfy the rule of equidistance for each U multiplet. The relations between the amplitudes of various electromagnetic transitions are determined for particles belonging to the same or to different unitary multiplets. For these transitions, there are selection rules $\Delta U = 0, \pm 1$. (M.J.T.)

5010 ELEMENTARY PARTICLES. A. A. Sokolov. Translated from Elementarnye Chastitsy by William E. Jones. A Pergamon Press Book. New York, The Macmillan Co., 1964. 80p. $1.95.

The theory of elementary particles and nuclear forces

is reviewed, together with associated experimental observations. The prediction and discovery of particles are stressed. (D.C.W.)

Field Theory and Quantum Mechanics

Refer also to abstracts 4965 and 5201.

5011 (CERN-64-42) SU_3 ET INTERACTIONS FAIBLES. (SU_3 and Weak Interactions). B. d'Espagnat (European Organization for Nuclear Research, Geneva). Sept. 24, 1964. 86p. Dep.(mn).

The lecture notes prepared for a series of seminars at Orsay are presented. The principal experimental facts and principal basic hypotheses, the theories of the "schizon" and "veton", pology and "dynamic" schemes, groups and weak interactions, unitary symmetry and non-leptonic interactions, weak leptonic interactions, non-leptonic interactions, non-leptonic interactions without R invariances, and intermediate bosons and unitary symmetry are reviewed. (J.S.R.)

5012 (COO-623-104) PROPERTIES OF BOSE GASES USING REDUCED DENSITY MATRICES (thesis). Technical Report No. 36. Donald Wright (Case Inst. of Tech., Cleveland). 1964. Contract AT(11-1)-623. 134p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Several thermodynamic and statistical properties of particular many-body systems are calculated. The systems considered are (a) a gas of particles obeying Bose-Einstein statistics and interacting through a hard-sphere potential, and (b) the same gas where the potential also contains a weak attractive interaction. The method of calculation makes use of the one- and two-particle density matrices and their connection with thermodynamic properties. The Bogoliubov formalism is also used. In addition to a confirmation of the thermodynamic properties already found by others using different methods, the thesis also contains a discussion of the correlations in the hard-sphere Bose gas, and in particular the connection between long-range order in the off-diagonal parts of the one- and two-particle density matrices. (auth)

5013 (ISS-64/13) INTRODUZIONE ALLA TEORIA DEI GRUPPI E ALLE SIMMETRIE UNITARIE (CICLO DI LEZIONI TENUTE DA L. MAIANI E G. DE FRANCESCHI). PARTE II. INTRODUZIONE AI MODELLI DI SIMMETRIE UNITARIE. (Introduction to Group Theory and Unitary Symmetry (A Course of Lectures Given by L. Maiani and G. De Franceschi). Part II. Introduction to Unitary Symmetry Models). G. De Franceschi (Italy. Istituto Superiore di Sanita, Rome). Apr. 20, 1964. 44p. Dep.(mn).

The notes of a series of lectures on the theory of group and unitary symmetry models are given. The isotopic spin and "Eightfold way" models for strongly interacting particles are considered from a unified point of view. The main results of the latter theory as well as the mass formula and the $\omega-\varphi$ mixing problem are also reported. (auth)

5014 (ISS-64/17) ELEMENTARY DISPERSION THEORY. I. M. Barbour (Italy. Istituto Superiore di Sanita, Rome). May 25, 1964. 67p. Dep.(mn).

The notes of a series of lectures on elementary dispersion theory are given. A short study is made of the analytic properties of scattering amplitudes in perturbation theory indicating the validity of a Mandelstam representation. The general method of solution proposed by Chew and Mandelstam is outlined, and a brief summary is given of some early applications of the theory. (auth)

5015 (JINR-P-1777) A RELYATIVISTSKOI ZADACHE TREKH TEL. (On Relativistic Three-Body Problem). D. Ts. Stoyanov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 15p.

Some relativistic analogs of Faddeev's equation were obtained from the Bethe-Salpeter equation for the three-particle Green's function with pair interactions. An expression for the scattering amplitude on the two-particle bound state was also obtained. (auth)

5016 (JINR-P-1793) OBSHCHIE PRINTSIPY LOKAL'NOI TEORII I IKH EKSPERIMENTAL'NYE SPEDSTVIYA. (General Principles of the Local Theory and Their Experimental Significance). A. A. Logunov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 28p. (CONF-550-72). Dep.(mn).

From The International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

The axiomatic approach of the quantum field theory has been undergoing a marked development. The studies carried out by A. S. Wightman and L. Cardin are especially significant in this respect. The approach is based primarily on the Heisenberg quantum field, defined as a generalized operator function. The theory requires invariance with respect to the inhomogeneous Lorentz group. When examining the scattering problems of the field theory, the concept of the asymptotic, free "in and out" fields must be applied, as described by D. Ruelle and R. Haag. The studies carried out on the basis of N. N. Bogolyubov's microcausality principle and the analytical properties of the scattering amplitudes are examined. Attention was given to the asymptotic correlation between amplitudes of elastic and inelastic processes and the particle-generation cross sections. A recent paper on inelastic processes involving particle generation was also considered, examining the π meson-nucleon collisions. It is shown that taking into account the electromagnetic interactions does not change the conclusions on the parity of the differential cross sections of particles and antiparticles in the high-energy range. (Review article, 54 references). (TTT)

5017 (JINR-P-1822) O TEORIYAKH VZAIMODEISTVUYUSHCHIKH POLEI SO SPINOM 1. (On Theories of Interacting Fields With Spin 1). V. I. Ogievetskii and I. V. Polubarinov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 8p. Dep.(mn).

A new derivation of symmetries inherent to the theories of interacting vector fields with spin 1 is given. An immediate connection of the requirement that the virtual vector quanta have spin 1, with the gauge invariance of these theories for the zero-mass vector fields is discussed. (auth)

5018 (KFKI-64-1) METOD FUNKTSII GRINA I EGO PRILOZHENIYA V TEORII MAGNETIZMA. (Green's Function and Its Application in the Theory of Magnetism). S. V. Tyablikov (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1964. 31p.

Green's quantum functions are very useful for investigating statistical mechanics problems. These functions were applied to the quantum theory of magnetism. The statistical mechanics and the quantum field theory deal with systems possessing many degrees of freedom. If N and V represent the number of particles in the system and the volume of the system, the studies are usually carried out under conditions of $N \to \infty$, $V \to \infty$, and $N/V \to \infty$. By increasing the volume, the energy will be increased in proportion to the volume. Application of perturbation theory to such systems causes the appearance of nonphysical members. The difficulties which may thus arise may be avoided by the application of Green's function, which also simplifies the numerical calculations. The function was widely applied in the quantum theory of magnetism, making use of the spectral concept of G. Chelen and G. Leman, as modified by V. L. Bonch-Bruevich, L. D. Landau, N. N. Bogolyubov, and others. Recent contributions to the theory are critically examined. (Review article, 39 references) (TTT)

5019 (ANL-Trans-123) THE APPLICATION OF THE METHOD OF COEFFICIENTS OF FRACTIONAL PARENTAGE TO MOLECULAR TERMS CALCULATIONS. I. G. Kaplan. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Lietuvos Fiz. Rinkinys, Lietuvos

TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 3: 1-2(1963). 9p. Dep.(mn); $1.00(cy) 1(mn) OTS; $1.10 (fs), $0.80(mf) JCL.

The coordinate wave function of N-particle systems at the Heitler-London approximation was constructed by means of Young's operators. Linear combination of these functions belonging to irreducible representation of a molecular point-symmetry group were found with the use of projection operators of the point-symmetry group. The expansion of the N-particle wave function into the product of the $(N-2)$-particle wave function and the function of the remaining two particles permits to express the matrix elements of the operator G in terms of two-particle matrix elements and coefficients of fractional parentage. Such coefficients for all the possible symmetries of particle systems with N = 3 to 6 have been tabulated. (auth)

5020 THE "CLOCK-PARADOX" AND THE QUANTUM-MECHANICAL THEORY OF BIOLOGICAL AGEING. M. Sueveges (Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung., 17: 395-7(1964).

A "clock" for measuring elapsed time in biological systems is defined as the number of somatic mutations induced in the system by the proton tunneling effect. The definition is based on Lowdin's quantum-mechanical hypothesis of biological aging. (D.C.W.)

5021 A COMMENT ON: A NEW METHOD FOR FINDING THE PHASE SHIFTS FOR THE SCHRÖDINGER EQUATION. John W. Sheldon (Lewis Research Center, Cleveland). Acta Phys. Acad. Sci. Hung., 17: 399-400(1964).

The phase shift difference obtained by Tietz is expressed in the Born approximation. (D.C.W.)

5022 A DIAGRAMMATIC METHOD FOR HANDLING INVARIANTS BUILT FROM 3-j SYMBOLS. Andrzej Kotański (Jagellonian Univ., Krakow) and Kacper Zalewski. Acta Phys. Polon., 26: 109-16(July 1964).

Diagrams corresponding to contracted products of 3-j symbols are introduced. There is exactly one invariant corresponding to each closed diagram. Identities for invariants follow from the rules for handling diagrams. Some illustrative examples are discussed. (auth)

5023 MOTION ACROSS MAGNETIC DISCONTINUITIES AND FERMI ACCELERATION OF CHARGED PARTICLES. Donat G. Wentzel (Princeton Univ., N. J.). Astrophys. J., 140: 1013-24(Oct. 1, 1964).

The motion of charged particles across stationary magnetic discontinuities is investigated. The constancy of the magnetic moment, a result of the guiding center approximation (GCA), is shown to hold for both weak shocks and shocks of arbitrary strength whose fronts are nearly parallel to the lines of force. For most other shocks, scattering of the pitch angle, relative to the change across the shock expected from the GCA, is limited to less than the angle between the lines of force at the shock. Only rather strong shocks can significantly randomize the pitch angles, and these result in non-uniform distributions in phase angle. Charged particles with Larmor radii large compared to the thickness of shock fronts but small compared to the length of the shock disturbances can be efficiently Fermi accelerated between series of converging shocks with equal amplitudes: A particle between diverging shocks cannot be trapped and decelerated, but, upon entering the region between converging shocks, it may be trapped and accelerated. The average efficiency of acceleration is estimated to be comparable to that of first-order Fermi acceleration. (auth)

5024 GEOMETRODYNAMICS: THE GEOMETRY OF SPACE-TIME. John G. Fletcher. Discovery, 25: No. 11, 34-8(Nov. 1964).

The geometry of electromagnetism and electric charge, the gravitating mass, measuring length with time, and quantum electrodynamics are discussed. The geometrodynamic view of the universe is that the distortions of varying shapes and sizes in space-time account for the varying amounts and kinds of matter and energy present. (C.E.S.)

5025 CALCULATIONS AND APPLICATIONS OF SCREENED HYDROGENIC WAVE FUNCTIONS. Ali M. Naqvi (Geophysics Corp. of America, Bedford, Mass. and Harvard Observatory, Cambridge, Mass.). J. Quant. Spectry. Radiative Transfer, 4: 597-615(Sept.-Oct. 1964).

The evaluation of screened-hydrogenic orbitals for a many-electron atom is considered. Expressions for Slater integrals and their derivatives with respect to the effective nuclear charges are given. The dipole matrix elements are evaluated for screened-hydrogenic orbitals as a function of the scaled nuclear charges of the initial and the final states of the active electron. Comparisons of predicted energies and transition integrals with experimental values and those based on the self-consistent field method are given. (auth)

5026 ON THE CALCULATION OF 6j-COEFFICIENTS. A. Bandzaitis, K. Zukauskas, A. Matulis, and A. Jucys (Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 35-43(1964). (In Russian)

Two new expressions for the 6j-coefficients are derived by the method proposed by Wigner. Both these formulas are transformed in the same way as in the case of the Racah formula by Sato. It is proposed to represent the 6j-coefficient with the aid of seven parameters (perimeters of four triangles and three quadrangles). The program for the calculation of 6j-coefficients on the computer BESM-2M is briefly characterized. (auth)

5027 ONCE MORE ON THE FORMULAS FOR THE CLEBSCH-GORDAN COEFFICIENTS. A. Bandzaitis and A. Jucys (Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 45-9(1964). (In Russian)

Contrary to the conclusion drawn previously besides existing three traditional formulas for the Clebsch–Gordan coefficients, two new formulas are derived. These formulas are obtained from the Wigner and Fock–Racah formulas correspondingly by the transformation procedure previously proposed in this connection. The Fock generating functions yielding these formulas are given as well. (auth)

5028 CLEBSCH-GORDAN COEFFICIENTS OF THE GROUPS D_2', D_3', AND D_6'. M. Balevičius and A. Bolotin (Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 67-80(1964). (In Russian)

The calculation of Clebsch–Gordan coefficients using the Racach lema is considered. These coefficients of the groups D_2', D_3', and D_6' are obtained. (auth)

5029 QUANTIZATION PROBLEMS OF GRAVITY. K. Just (Univ. of Arizona, Tucson). Nuovo Cimento (10), 34: 567-80(Nov. 1, 1964).

Einstein's theory (as quantized) is discussed with respect to its gauge transformations, the commutator of the asymptotic fields, and the spinless part of its interacting field. (auth)

5030 CLASSICAL APPROXIMATION FOR THE CHANGE OF POLARIZATION IN POTENTIAL SCATTERING. Pao Lu, D. M. Fradkin, and R. H. Good, Jr. (Ames Lab., Ames, Iowa). Nuovo Cimento (10), 34: 581-90(Nov. 1, 1964). (IS-847)

This paper gives the classical approximation for the change of polarization of a relativistic particle scattered by a central force. It is shown that the polarization precesses about the angular momentum, and the problem of finding the total precession angle is reduced to a quadrature. The range of validity of the approximation is discussed and the classical results are compared with the quantum-mechanical results for the Coulomb scattering of a Dirac particle with normal magnetic moment. (auth)

5031 A METHOD OF SOLVING THE MANY-BODY K-MATRIX. K. W. Wong (State Univ. of Iowa, Iowa City). Nuovo Cimento (10), 34: 591-8(Nov. 1, 1964).

If the matrix element of a central potential can be approximated by a finite series, then the K matrix can be

solved in a closed form. The classes of Bose statistics and Fermi statistics are treated. For the Fermi case we have considered both the K matrix equation without hole-hole interaction and with hole-hole interaction. (auth)

5032 ON A CLASSICAL STATISTICAL MODEL WITH THE NONRELATIVISTIC INTEGRALS OF MOTION. H. Joos and H. Satz (Deutsches Elektronen-Synchrotron DESY, Hamburg). Nuovo Cimento (10), 34: 619-31(Nov. 1, 1964).

The classical nonrelativistic phase-space integral for fixed energy, momentum, angular momentum, and center of mass is evaluated for large particle numbers by means of the central limit theorem of statistics. The problem is treated covariantly with respect to all transformations of the Galilei group. As a result we get Ω_s as function of the invariants corresponding to the c.m.s. energy E_0 and angular momentum L_0 in the form $\Omega_s(E_0, L_0^2) = \Omega_s(E_0)F(L_0^2, E_0)$. $\Omega_s(E_0)$ is the phase-space at fixed energy, momentum and center of mass, and $F(E_0, L_0^2) = [3/4\pi mR^2E_0]^{\frac{1}{2}} \exp[-(3L_0^2/4mR^2E_0)]$ is a normalized probability density for the angular momentum L_0^2. (auth)

5033 SUM RULES FOR GRADIENT-COUPLED THEORIES. W. S. Hellman (Naval Ordnance Lab., Silver Spring, Md.). Nuovo Cimento (10), 34: 632-6(Nov. 1, 1964).

The sum rules for a pseudoscalar boson-nucleon system with gradient coupling are examined. Mass formulae are obtained for a massive vector meson coupled to a conserved current. (auth)

5034 ON A CLASS OF THIRRING MODELS. C. S. Lam (Univ. of Maryland, College Park). Nuovo Cimento (10), 34: 637-44(Nov. 1, 1964).

A class of Thirring models self-coupled through a noncovariant current operator is investigated. It is shown that such a coupling will lead to physically meaningful results only at a fixed coupling strength. Furthermore, symmetry-breaking solutions are permissible only at this particular coupling strength. The question of zero-mass bosons is discussed. (auth)

5035 THE RICCATI EQUATION AND REGGE POLES. K. Chadan and J. Y. Guennegues (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 34: 665-89(Nov. 1, 1964).

The Schrödinger equation with a central potential is transformed into a Riccati equation by methods of the theory of ordinary differential equations. The equation is chosen in such a way that its solution, in the limit $r \to \infty$, gives the scattering amplitude. By studying the analyticity of the solution and of its limit, one can therefore obtain information on the domains in energy and angular momentum where poles cannot lie. As it is shown, the limitations one obtains on the location of Regge poles are very severe. For usual superpositions of Yukawa potentials, poles in the λ-plane must lie in small finite domains for all energies in a large region of the complex plane. In particular, this region includes the whole real positive energy axis ($E \geq 0$). As a result, dispersion relations in momentum transfer need at most a finite number of subtractions. Finally, the amplitude is shown to vanish when λ goes to infinity in the entire right-hand half-plane, including the imaginary axis. (auth)

5036 SINGULAR POTENTIALS IN NONRELATIVISTIC QUANTUM MECHANICS. K. Meetz (Universität, Hamburg). Nuovo Cimento (10), 34: 690-708(Nov. 1, 1964).

The mathematical aspects of singular potentials in nonrelativistic quantum mechanics are studied in terms of the self-adjoint transformations related to singular differential operators in the space $L_2(0, \infty)$. The physical content is expressed by the spectral decompositions and (for attractive potentials) found to be determined only up to a parameter defining a particular extension. In general it is not possible to determine a specific extension by a cut-off procedure. (auth)

5037 THE TRIALITY QUANTUM NUMBER IN SU_3 AND U_3 SYMMETRY AND ITS APPLICATION TO WEAK INTERACTIONS. S. Okubo, C. Ryan, and R. E. Marshak (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 34: 759-67(Nov. 1, 1964). (UR-875-37)

The definition of the triality quantum number in both the SU_3 and U_3 groups is investigated in connection with the problem of fractionally charged particles. It is shown that in order to describe a triplet of particles having integral values of charge and hypercharge it is necessary and sufficient to use the group U_3 rather than the group SU_3. Finally as an application we investigate the possibility that leptons may belong to unitary triplets in weak interactions. (auth)

5038 COHERENCE OF FUNCTIONS. J. Peřina (Palacký Univ., Olomouc, Czechoslovakia). Phys. Letters, 12: 194-5(Oct. 1, 1964).

The properties of coherence in the mathematical sense are applied to atomic-spectra coherence in the case in which the propagating signals are nonlinear. (T.F.H.)

5039 NORMAL ORDERED PROJECTION OPERATORS FOR PHOTON PROBABILITIES. F. Ghielmetti (Universität, Bern). Phys. Letters, 12: 210-11(Oct. 1, 1964).

An expression, derived on the basis of semiclassical arguments, for the probability of finding any given number of photons in a given volume at a given instant of time is considered. It is shown that this expression is a straightforward consequence of the usual definition of the number operator for photons in the volume considered. (T.F.H.)

5040 TEST OF THE SECOND POSTULATE OF SPECIAL RELATIVITY IN THE Gev REGION. T. Alvaeger, F. J. M. Farley, J. Kjellman, and I. Wallin (CERN, Geneva). Phys. Letters, 12: 260-2(Oct. 1, 1964).

If the velocity (c′) of electromagnetic radiation emitted by a body moving with velocity v is given by $c' = c + kv$, where k is a constant, it is shown experimentally that $k = (-3 \pm 13) \times 10^{-5}$. The experiment is carried out by measuring the velocities of gamma rays emitted by π^0 mesons having energies above 6 Bev. (T.F.H.)

5041 MASS RENORMALIZATION IN QUANTUM FIELD THEORY. [PART] II. C. R. Hagen (Univ. of Rochester, N. Y.). Phys. Letters, 12: 267-9(Oct. 1, 1964). (UR-875-49)

It is shown that a dispersion theoretical approach to renormalization leads to a result that has no direct connection with quantum field theory. On the other hand, the extended Zachariasen model is found to yield trivially the result that in the limit as $Z_3 = 0$ the mass renormalization diverges under quite general conditions, and consequently leads to a degeneration of the equation of motion of the elementary particle field. (T.F.H.)

5042 POSITION AND MOMENTUM EIGENFUNCTIONS. SQUARE ROOTS OF ν AND δ. D. Judge (University Coll., Dublin). Phys. Letters, 13: 138-9(Nov. 15, 1964).

An approach to the normalization of momentum and position eigenfunctions is outlined. (D.C.W.)

5043 ELECTROMAGNETIC AND WEAK INTERACTIONS. A. Salam and J. C. Ward (Imperial Coll. of Science and Tech., London). Phys. Letters, 13: 168-71(Nov. 15, 1964).

A synthesis of electromagnetism and weak interactions is sought in terms of a group structure for which the contrasting space-time behavior (V for electromagnetic vs V and A for weak interactions) and the contrasting ΔS and ΔI behaviors both appear as aspects of the same fundamental symmetry. (D.C.W.)

5044 QUANTIZATION OF DIRAC'S SPINOR FIELD WITHOUT INFINITIES OF NEGATIVE ENERGY. V. Vyšín (Palasky Univ., Olomouc, Czechoslovakia). Phys. Letters, 13: 217-19(Dec. 1, 1964).

It was previously shown that some of the difficulties in the quantization of the Dirac spinor field are connected with the existence of the solutions for negative energy states. One can avoid these difficulties by means of a subtraction

formalism, but it is thought that this procedure is not physically justified. The possibility of the quantization of the spinor field without using a subtraction formalism is considered. (C.E.S.)

5045 FINITE SELF-ENERGY OF PARTICLE IN UNRENORMALIZATION QUANTUM FIELD THEORY. F. Bopp (Universität, Munich). Phys. Letters, 13: 260-2 (Dec. 1, 1964). (In German)

It is shown that relativistic quantum field theory can be attained without singularities from classical field equations by canonical quantization. An example is used which enables electrons and muons to be understood as particles of quantum electrodynamics. (L.B.S.)

5046 GLOBAL CONSERVATION LAWS AND MASSLESS PARTICLES. G. S. Guralnik, C. R. Hagen, and T. W. B. Kibble (Imperial Coll. of Science and Tech., London). Phys. Rev. Letters, 13: 585-7(Nov. 16, 1964).

It is shown, within the framework of a simple soluble field theory, that it is possible consistently to break a symmetry (in the sense that $\Sigma_k t_{ijk} < 0/A_k/0 > \neq 0$) without requiring that A(x) excite a zero-mass particle. Although this result suggests a general procedure for the elimination of unwanted massless bosons, it is shown that this was accomplished by giving up the global conservation law usually implied by invariance under a local gauge group. The consequent time dependence of the generators Q_i destroys the usual global operator rules of quantum field theory (while leaving the local algebra unchanged), in such a way as to preclude the possibility of applying the Goldstone theorem. It is clear that such a modification of the basic operator relations is a far more drastic step than that taken in the usual broken-symmetry theories in which a degenerate vacuum is the sole symmetry-breaking agent, and the operator algebra possesses the full symmetry. (C.E.S.)

5047 ON THE GRAVITATIONAL INFLUENCE OF DIRECT PARTICLE FIELDS. F. Hoyle (St. John's Coll., Cambridge, Eng.) and J. V. Narlikar. Proc. Roy. Soc. (London), Ser. A, 282: 184-90(Nov. 3, 1964).

The problem of the contribution of direct particle interaction of the Fokker type to the gravitational equations is solved. It is shown that the usual procedure for obtaining the gravitational equations, of making small variations of geometry, $g_{ik} + \delta g_{ik}$ replacing g_{ik} in finite regions, with $\delta g_{ik} = 0$ on their boundaries, and of requiring that the action be stationary for such variations, can be carried through with the aid of Green functions. This procedure, due to Hilbert, serves to define the energy tensor T_{ik} associated with each of the fields. That for the C-field turns out exactly the same as we have used in the macroscopic form of the theory. That for the electromagnetic field turns out to have some new features. These are terms containing the vector potential and its derivative when worldlines are broken, although these terms vanish when there is charge conservation. The terms in the field F_{ik} are identical with the usual tensor if the field is calculated from retarded potentials. In former work no decision was made on the form the tensor should take when the potentials are ½ (retarded + advanced). Wheeler & Feynman showed that alternative choices are possible and that a decision cannot be made from electromagnetic considerations alone. The analysis leads to a unique result, the Frenkel tensor. (auth)

5048 A NEW THEORY OF GRAVITATION. F. Hoyle (St. John's Coll., Cambridge, Eng.) and J. V. Narlikar. Proc. Roy. Soc. (London), Ser. A, 282: 191-207(Nov. 3, 1964).

A new theory of gravitation is developed. The theory is equivalent to that of Einstein in the description of macroscopic phenomena, and hence the situation is the same so far as the classical tests of general relativity are concerned. The new theory differs in its global implications, however. There are two main differences of principle. In the usual theory, the negative sign of the constant of proportionality $-8\pi G$ which appears in the field equations $R^{ik} - \frac{1}{2}g^{ik}R = -8\pi GT^{ik}$ is chosen arbitrarily. In this theory there is no such ambiguity; the sign must be minus. Further, the magnitude of G follows from a determination of the mean density of matter, thereby enabling the cosmologist to know how hard he will hit the ground if he is unfortunate enough to fall over a cliff. The second point of principle is that the equation $R_{ik} = 0$ for an empty world in Einstein theory becomes meaningless; there is no such thing as an empty world; in the theory emptiness demands no world at all. Nor can there be a world containing a single particle; the least number of particles is two. (auth)

5049 THE QUANTUM MECHANICAL FOUR-BODY PROBLEM. S. Fluegge and W. Pieper (Universität, Freiburg i. B.). Z. Physik, 181: 261-72(1964). (In German)

The Schrödinger equation of the four-body problem was transformed to appropriate coordinates. Besides those of the center of mass, these are the six distances between the four particles and the Eulerian angles describing the orientation of the instantaneous ellipsoid of inertia. By introduction of the angular momentum operators $L_{x'}$, $L_{y'}$, $L_{z'}$ the wave equation becomes fully symmetrical not only in the distances but also in these three operators. The solution can be written as a linear combination of the eigenfunctions of the rigid rotator with coefficients depending upon the particle distances. The system of differential equations for these coefficient functions was given; its behavior under parity transformation turns out to be rather more involved than in the three-particle case. (auth)

5050 HIGH-ENERGY ASYMPTOTIC BEHAVIOR OF CONVERGING FEYNMAN DIAGRAMS. O. I. Zavyalov (Inst. of Mathematics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1099-1107(Sept. 1964). (In Russian)

A method is formulated which permits one to determine the asymptotic terms of any converging plane diagram on the basis of its topological structure. (auth)

5051 THE RADIATION FROM A LINEAR SOURCE, MOVING NEAR A DIFFRACTION GRATING CONSISTING OF A SYSTEM OF IDEALLY CONDUCTING SEMIPLANES. B. M. Bolotovskii and G. V. Voskresenskii. Zh. Tekhn. Fiz., 34: 1856-62(Oct. 1964). (In Russian)

The problem of the excitation of equidistant ideally conducting semiplanes moving as a uniform current or charged filament is reduced to a paired integral equation system. The system is resolved by the Wiener-Hopf method. A concept is found for the free space field and for proper waves excited between the semiplanes. (tr-auth)

5052 ON THE ASYMPTOTIC PROPERTIES OF DYNAMIC VARIABLES IN THE THEORY OF SPINOR AND MESON FIELDS. Yu. P. Pytev. Zh. Vychislitel. Mat. i Mat. Fiz., 4: 871-9(Sept.-Oct. 1964). (In Russian)

The asymptotic properties of dynamic variables and the conservation law in field theory are interpreted using Schwartz distribution theory. It is shown that dynamic variables (and consequently the conservation law) in the singular field region do not contain data on the multicomponent field. (R.V.J.)

5053 THE INVERSE PROBLEM OF SCATTERING THEORY. Z. S. Agranovich and V. A. Marchenko. Translation by B. D. Seckler of "Obratnaya Zadacha Teorii Rasseyaniya." New York, Gordon and Breach Science Publishers, 1963. 300p. (This Book in Original Russian Abstracted in NSA, 16: 9410).

The inverse problem in the quantum theory of scattering is analyzed. The boundary-value problem with and without singularities is treated. An abstract was previously prepared from the original Russian NSA, 16: 9410. (D.C.W.)

Geophysics

Refer also to abstract 5324.

5054 (FTD-TT-64-1077(p.173-90)) RECORDING THE EFFECTS OF THE HIGH-ALTITUDE THERMONUCLEAR

EXPLOSION OF 9 JULY 1962 WITH THE "KOSMOS-5" SATELLITE. Yu. I. Gal'perin and A. D. Bolyunova. Translated from Kosmich. Issled., 2: 763-72(1964).

Satellite results of radiation measurements at the time of the Johnston Island burst are reported. (R.E.U.)

5055 (FTD-TT-64-1077(p.258-60)) DISTRIBUTION CHARACTERISTICS OF ELECTRONS WITH ENERGIES AROUND 100 Kev AT MODERATELY HIGH ALTITUDES ABOVE THE EARTH. V. V. Temnyi (Temnyy). Translated from Kosmich. Issled., 2: 812-13(1964).

Data on electron distributions in the geomagnetic field prior to 9 July 1962 is reviewed. Possible mechanisms of scatter and escape are discussed. (R.E.U.)

5056 SIMULATION OF GEOPHYSICAL PHENOMENA IN THE LABORATORY. M. P. Bachynski (RCA Victor Research Labs., Montreal). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 1873-82(Nov. 1964).

The advancement of plasma technology to the position where it is becoming feasible to perform laboratory experiments designed to simulate various aspects of geophysical phenomena is discussed, and a number of these experiments are summarized. 96 references. (C.E.S.)

5057 F REGION DRIFT AND ANISOTROPY PARAMETERS UNDER SPREAD-F CONDITIONS. B. V. Krishna Murthy and B. Ramachandra Rao (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 2: 302-4(Sept. 1964).

Drift records taken under spread-F conditions in the ionosphere over Waltair, a low latitude station (17°43'N, geograph. lat. and 7.4°N, geomag. lat.) were analyzed. The true drift was found to be mainly in the N-E and S-E quadrants. It was observed that the N-S component of the true drift fluctuates between north and south under spread-F conditions, while it is consistently toward the north under normal conditions; the E-W component, however, remains unaffected. The axial ratio of the characteristic ellipse of irregularities increases, and its orientation remains unaffected under spread-F conditions. The variation under spread-F conditions of the parameters of the characteristic ellipse of the irregularity pattern at Waltair was found to be, in general, similar to that observed for high-latitude stations. (auth)

5058 SPACE-TIME ASSOCIATIONS OF THE AURORA AND MAGNETIC DISTURBANCE. J. K. Walker (Dominion Observatory, Ottawa). J. Atmospheric Terrest. Phys., 26: 951-8(Oct. 1964).

Relations between the position and intensity of aurora and the corresponding auroral electrojets in central Canada were examined for eight moderate polar magnetic storms during 1957-58 using the IGY network of all-sky cameras, auroral intensity recorders and magnetic variation stations. The estimated auroral brightness and auroral electrojets intensity were plotted on maps and transferred to give a time sequence of a meridian section. The intensity, direction, geographic distribution, and motion relations of the aurora and the auroral electrojet were observed to be generally coincident. Oppositely directed electrojets were found to exist close to each other in the ionosphere near local midnight, indicating that an appreciable part of the electric field could be magnetospheric in origin. (auth)

5059 NON-DIURNAL E-LAYER VARIATIONS AT WASHINGTON D. C. V. R. Noonkester (Navy Electronics Lab., San Diego, Calif.). J. Atmospheric Terrest. Phys., 26: 965-77(Oct. 1964).

Non-diurnal E-layer variations were examined using a noon-time centered seven-hour average of the minimum virtual height $h'E$ and the ordinary wave critical frequency f_0E. These averages, $\overline{h'}$ and $\overline{f}$ respectively, were computed for an eight-year period at Washington, D. C. $\overline{f}$ was found to vary with the Zurich sunspot number R in accordance with previous studies. $\overline{h'}$ was found to be 101 km for an overhead sun and to increase with R. Variations in $\overline{h'}$ indicated a scale height between about 7 and 8 km. $\overline{h'}$ had no periodicities. $\overline{f}$ had a strong 27-day periodicity between the maximum and minimum R and a very weak 27-day periodicity during the maximum and minimum R. Non-Chapman variations in $\overline{f}$ and $\overline{h}$ were uncorrelated. (auth)

5060 ARTIFICIAL AURORAE FROM HIGH-ALTITUDE NUCLEAR TESTS. J. G. Keys (P.E.L. Auroral Station, Omakau, N. Z.). J. Atmospheric Terrest. Phys., 26: 979-93(Oct. 1964).

High-altitude nuclear explosions near Johnston Island in the latter part of 1962 produced artificial auroras in the magnetically conjugate region observable from Western Samoa and other Pacific islands. Variations of the conjugate effects in position, intensity and color with time, and the relation of these effects with the probable excitation mechanism are discussed. (auth)

5061 REMARKS ON PAPER BY P. J. DREVINSKY, J. T. WASSON, E. C. COUBLE, AND N. A. DIMOND, "Be^7, P^{32}, P^{33}, AND S^{35}: STRATOSPHERIC CONCENTRATIONS AND ARTIFICIAL PRODUCTION." J. F. Bleichrodt (National Defence Research Organization TNO, Rijswijk, Netherlands). REPLY. P. J. Drevinsky and J. T. Wasson (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 69: 4903-6(Nov. 15, 1964).

It is shown that the explanation proposed by Drevinsky for the stratospheric concentration of ^7Be observed in 1961 and 1962 is quite unlikely. A reply is presented by Drevinsky. (D.C.W.)

5062 DISTRIBUTION OF DENSITY IN AN ION-EXOSPHERE OF A NONROTATING PLANET. Aharon Eviatar, Allen M. Lenchek, and S. Fred Singer (Univ. of Maryland, College Park). Phys. Fluids, 7: 1775-9(Nov. 1964).

A model of an ion-exosphere is set up and an expression is derived for the variation of density with altitude. The ions are considered to be under the control of superimposed gravitational and static, centered-dipole magnetic fields and to have mirror points in the barosphere. Collisions are ignored and the particles are assumed to be trapped in the dipole field. By use of the first adiabatic invariant and Liouville's theorem, the density is found to fall off faster with height in the exomagnetosphere than in either a neutral exosphere or an ionized barosphere. (auth)

5063 ON THE HEIGHT OF AURORAL ABSORPTION. [PART] II. Bengt Hultqvist (Goddard Space Flight Center, Greenbelt, Md.). Planetary Space Sci., 12: 1035-44(Nov. 1964).

Statistical data from Alouette and Injun 3 giving the average precipitation rate of electrons in the auroral zone as a function of energy are analyzed with regard to the average radiowave absorption produced by ionization by electrons in the energy ranges from 1 to 40 kev and from 40 to 250 kev. From the satellite data, it is found that the higher energy range for the primary electrons is dominant in producing absorption at riometer frequencies. From this it follows that the majority of auroral absorption takes place below 90 km altitude in the auroral zone. (auth)

5064 IONIZATION IN THE EARTH'S ATMOSPHERE BY AURORALLY ASSOCIATED BREMSSTRAHLUNG X-RAYS. Manfred H. Rees (Univ. of Colorado, Boulder). Planetary Space Sci., 12: 1093-1108(Nov. 1964).

The production of bremsstrahlung x rays associated with energetic auroral electron streams is calculated, and the ionization rate due to the x rays is determined. The incident electron stream is assumed to have an isotropic angular distribution over the downward hemisphere; energy distribution functions which closely predict luminosity profiles of N_2^+ radiation are adopted. Bremsstrahlung ionization production peaks at altitudes between 40 and 74 km for electron streams yielding auroral height-luminosity profiles which have a maximum in the range 100 to 120 km, but the ionization rate due to bremsstrahlung is several powers of ten below that obtained from direct ionization by electron impact. The spectral distribution and flux of x rays associated with auroral bombardment are predicted at various altitudes, particularly in the height range reached by balloons. (auth)

5065 THE ELECTRON DENSITY DISTRIBUTION IN THE TOPSIDE IONOSPHERE. I. MAGNETIC-FIELD-ALIGNED STRATA. J. Sayers (Univ. of Birmingham, Eng.). Proc. Roy. Soc. (London), Ser. A, 281: 450-8(Oct. 6, 1964).

The electron density distribution in the topside ionosphere was measured using an r-f electron probe. Enhancement of the electron density on various magnetic shells was observed, the altitude of the enhanced regions varying with longitude and latitude. An explanation of the observations was sought. (D.C.W.)

5066 THE ELECTRON DENSITY DISTRIBUTION IN THE TOPSIDE IONOSPHERE. II. EFFECTS OF THE NUCLEAR EXPLOSION OVER JOHNSTON ISLAND AND THE IONIZATION PRODUCED BY CORPUSCULAR RADIATION AT HIGH MAGNETIC LATITUDES. J. Sayers. Proc. Roy. Soc. (London), Ser. A, 281: 459-64(Oct. 6, 1964).

The results of satellite observations on the electron density before and after the Starfish event and during a sudden commencement are discussed, together with observations on the variation of the electron density with the K_p index of geomagnetic activity at high magnetic latitudes. It appears that corpuscular radiation is a major source of ionization in the topside ionosphere in regions intersected by high magnetic shells. (D.C.W.)

5067 PRELIMINARY INVESTIGATION OF THE STRUCTURE OF THE UPPER IONOSPHERE AS OBSERVED BY THE TOPSIDE SOUNDER SATELLITE, ALOUETTE. J. W. King, P. A. Smith, D. Eccles, G. F. Fooks, and H. Helm (D.S.I.R. Radio Research Station, Slough, Bucks., Eng.). Proc. Roy. Soc. (London), Ser. A, 281: 464-87(Oct. 6, 1964).

Results are presented which illustrate the shape of the topside electron distributions at different local times and different latitudes. It is shown that the ionosphere appears to cool and contract during the night. The morphology and diurnal variation of the geomagnetic equatorial anomaly was investigated. The structure of the equatorial topside ionosphere appears to be determined by the earth's magnetic field, and the geomagnetic anomaly is shown to exist in the topside only between 10:00 and 22:00 local time. Deductions about the composition or temperature of the atmosphere are shown to be complicated because diffusion occurs along field lines only and also because the temperature increases with height above ground. The scale height of the electron density distributions is found to increase with latitude, and it is shown that this effect is probably related to an increase of electron temperature with latitude. Five different localized phenomena were observed in the ionosphere by the topside sounder, and three of these are shown to occur at the latitudes at which the magnetic field lines which pass through the hearts of the three radiation belts enter the earth's atmosphere. Other results are presented which indicate that particles dumped from the radiation belts may be important sources of heat or ionization in the atmosphere. Observations made at sunrise and also during an eclipse indicate that the effects of electromagnetic movements and/or movements produced by temperature changes are very important in the upper ionosphere. (auth)

5068 EXPLORER VIII SATELLITE MEASUREMENTS IN THE UPPER IONOSPHERE. R. E. Bourdeau and J. L. Donley (Goddard Space Flight Center, Greenbelt, Md.). Proc. Roy. Soc. (London), Ser. A, 281: 487-504(Oct. 6, 1964).

Results from an ion retarding potential experiment show that the upper ionospheric composition responds to the neutral gas temperature. Specifically, during the satellite's active life (November–December 1960), O^+ ions predominated from the perigee altitude (425 km) up to about 800 km at night and 1500 km at diurnal maximum. The base of the helium ion region was located at 800 km during the sunrise period and at 1500 km in the daytime; the base of the protonosphere possibly was located at 1200 km during the sunrise period and above 1800 km at diurnal maximum. For the latitudes indicated, the electron temperature (T_e) data, which are restricted to magnetically quiet days ($A_p < 15$), are consistent with current models of the diurnal electron density behavior and with a hypothesis of solar ultraviolet radiation as the only ionizing agent. For the 6-hr period centered at midnight, the average T_e observed at altitudes of 425 to 600 km was 900°K with a standard deviation of 150°K. There were no anomalously high values and no significant change with magnetic dip (0 to 75°N). For the period 10 to 16 hr L.M.T., at magnetic dips between 50 and 70°S and at altitudes between 1000 and 2400 km, the observed average T_e was 1600°K (s.d. 200°K). The most pronounced feature of the measured diurnal variation is that T_e exceeds the neutral gas temperature by a factor of about 2.5 during the sunrise period at 600 to 900 km. Suggestions are made for the explanation of differences between the Explorer VIII T_e observations and other measurements. The measured satellite-plasma interaction is consistent with theoretical expectation lending confidence to the above-described geophysical results. The observed "average" potential of the satellite varied from a few tenths of a volt negative at night, to zero when the measured daytime charged particle density was 10^4 cm^{-3} and then to a few tenths of a volt positive for daytime densities of 10^3 cm^{-3}. Superimposed on the "average" potential were potential gradients across the satellite skin, an effect produced by the movement of a conducting body through a magnetic field. The measured orientation sensitivity of three types of current flowing between the satellite and the ionosphere is described. (auth)

5069 ION COMPOSITION OF THE UPPER F-REGION. P. J. Bowen, R. L. F. Boyd, W. J. Raitt, and A. P. Willmore, (London Univ.). Proc. Roy. Soc. (London), Ser. A, 281: 504-14(Oct. 6, 1964).

The relative concentrations of ions (particularly He^+, H^+, and O^+) in the upper F-region were investigated, with consideration of both the temporal and spatial variations of the ion composition. (D.C.W.)

5070 MEASUREMENT OF ELECTRON TEMPERATURE AND CONCENTRATION FROM A SPACECRAFT. P. J. Bowen, R. L. F. Boyd, C. L. Henderson, and A. P. Willmore (London Univ.). Proc. Roy. Soc. (London), Ser. A, 281: 514-25(Oct. 6, 1964).

The energy distribution of ionospheric electrons was investigated, using the Ariel I satellite. The disturbance of the electron density and temperature due to passage of the satellite through the ionosphere was also studied. The electrons were found to have a Maxwellian energy distribution. The observed charge distribution around the satellite was in good agreement with the predictions of Gurevitch; a marked charge depletion was noted in the wake. (D.C.W.)

5071 ELECTRON TEMPERATURE IN THE UPPER F-REGION. P. J. Bowen, R. L. F. Boyd, C. L. Henderson, and A. P. Willmore (London Univ.). Proc. Roy. Soc. (London), Ser. A, 281: 526-38(Oct. 6, 1964).

The density and temperature of ionospheric electrons were measured by two Langmuir probes carried by the Ariel I satellite. The storage and processing of the probe measurements are discussed, and the analysis of the electron temperature data is described. The electron temperature distribution between 400 and 1200 km was found to be strongly controlled by the geomagnetic field and to exhibit an increase with geomagnetic latitude and with altitude. (D.C.W.)

5072 THE ARTIFICIAL RADIATION BELT PRODUCED BY THE STARFISH NUCLEAR EXPLOSION. A. C. Durney, H. Elliot, R. J. Hynds, and J. J. Quenby (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A, 281: 565-83(Oct. 6, 1964).

Analysis of energetic particle flux measurements from Ariel I has led to a number of interesting conclusions about the effects of the Starfish nuclear explosion. It appears that the hydromagnetic shock wave generated by the explosion and propagated through the magnetosphere resulted in the disrupting of some outer belt electrons into the atmosphere. Following the explosion, a shell of electrons, centered at L = 1.12 and continuously fed by fission fragments remain-

ing in the vicinity of Johnston Island, was formed and lasted for at least 1 day. Arguments are given to support the view that the majority of the beta particles from the fission fragments were injected into the earth's magnetic field at altitudes less than 1000 km, although some electrons—which probably came from the decay of neutral fission fragments—appeared as far out as L = 6.5. At high L values the spectrum of the additional electrons was softer than that of the beta decay electrons from fission fragments. (auth)

5073 ON THE PROBLEM OF WAVE PROPAGATION BETWEEN THE EARTH AND IONOSPHERE. B. Z. Katzenellenbaum. Radiotekhn. i Elektron., 9: 1875-7(Oct. 1964). (In Russian)

Formulas were developed for monochromatic wave propagation between the Earth and ionosphere. The two-dimensional plane problem for horizontal polarization of electric field was resolved considering the earth and ionosphere to be parallel and the dielectric ionosphere penetrability to vary linearly with elevation and frequency. (R.V.J.)

5074 GEOMAGNETIC PULSATIONS AND THE EXOSPHERE. PART II. ANALYSIS OF SLIDING TONES. Tai-Ichi Kitamura (Doshisha Univ., Kyoto). Rept. Ionosphere Space Res. Japan, 18: 1-15(1964).

A quantitative analysis of the Cavity mechanism as a cause of sliding tones is given, where an analogy of the elastic string model is used. It is shown that the ascending and descending tones are possibly interpreted as caused by the compression and depression of the cavity bounded by the lines of force. The compression and depression rates are calculated, and the results are applied to sliding tone phenomena associated with a quasi-stationary solar wind, associated with an impulsive solar wind, and associated with a severe storm solar wind. (auth)

5075 A HYDROMAGNETIC INTERPRETATION OF GEOMAGNETIC SSC*. Tsutomu Tamao (Tohoku Univ., Sendai). Rept. Ionosphere Space Res. Japan, 18: 16-31 (1964).

A possible mechanism of the equivalent current system of geomagnetic ssc* is examined. Based on characteristics of three-dimensional propagation of hydromagnetic waves in a cold plasma, it is suggested that the direct source of the preliminary reverse impulse of ssc* is ionospheric Hall-currents in high latitudes caused by the incidence of mixed transverse hydromagnetic waves (pure transverse plus converted transverse). These waves are produced in the outermost magnetosphere of the daylight side by compression of the plasma at the very beginning of a storm, and propagate to high latitudes in both hemispheres accompanying the space charges, of which sign are negative in the morning and positive in the evening side, respectively. The preliminary reverse impulse in the equatorial region may be also explainable by the westward equatorial electrojet caused by the westward electric field belonging to the converted transverse mode. Qualitative discussion on the time sequence of an ssc phenomenon is also given. (auth)

5076 CATALOGUE OF DISTURBANCES IN IONOSPHERE, GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO WAVE, COSMIC RAY SOLAR PHENOMENA AND OTHER RELATED PHENOMENA. No. 47. APRIL 30–MAY 4, 1963. Rept. Ionosphere Space Res. Japan, 18: 47-81(1964).

Observational data on disturbances in the ionosphere, geomagnetic field, field intensity of radio waves, cosmic radiation, solar phenomena, and other related phenomena are presented for the period April 30th to May 4th 1963. (C.E.S.)

5077 MAGNETOSPHERIC GENERAL CIRCULATIONS AND CURRENT-SYSTEMS OF GEOMAGNETIC DISTURBANCE IN HIGH LATITUDES. Takasi Oguti (Tokyo Univ.). Rept. Ionosphere Space Res. Japan, 18: 109-21(1964).

A possibility is examined whether the electric fields in the polar ionosphere responsible for the S_q^p-type and SD-type current-systems are resulted from the general circulation of magnetospheric plasma. The general magnetospheric circulation of the fundamental mode would produce the electric field in the polar ionosphere which would be responsible for the current-system corresponding to S_q^p, polar part of SC and polar part of initial phase of geomagnetic storms. The circulation of the second harmonic mode would result in the electric field which causes SD electric current-system. (auth)

5078 EFFECT OF DYNAMO-ELECTRIC FIELD ON ELECTRONS IN THE MAGNETOSPHERE. Ken-Ichi Maeda (Kyoto Univ.). Rept. Ionosphere Space Res. Japan, 18: 125-9(1964).

According to the dynamo theory the air movement in the ionosphere induces an electric current, and such a current flows mainly in the E region and an electrostatic field is set up. The drift component of electrons in the geomagnetic meridian plane is perpendicular to the geomagnetic field and the other component is in the longitudinal direction. If the former component of electron drift is outward, the point (apex) for the electron orbit to cut the equatorial plane goes up, and vice versa. At the same time the mirror point will be affected. Calculations are presented for the time required for the electron transit from the mirror point to the geomagnetic equatorial plane, the change of apex of the electron orbit in one return transit from the equatorial plane to the mirror point and return (ΔH), the change of mirror point, the poleward or equatorward shift of the mirror point, longitudinal drift, number of collisions in transit from mirror point to equatorial plane, and the integrated effect of ΔH due to repetition of electron transits between two conjugate mirror points. (C.E.S.)

5079 SUMMARY OF DAILY OBSERVATIONAL RESULTS OF SOLAR PHENOMENA, COSMIC RAY, GEOMAGNETIC VARIATION, IONOSPHERE, RADIO WAVE PROPAGATION AND AIRGLOW, DURING JANUARY THROUGH DECEMBER 1963. Rept. Ionosphere Space Res. Japan, 18: 145-60(1964).

Daily observational results of solar phenomena, cosmic radiation, geomagnetic variation, ionosphere, radio wave propagation, and airglow are presented for Jan. to Dec. 1963. The results are arranged by the solar rotation number. (C.E.S.)

5080 POLAR AURORAS. V. I. Krasovskii (Inst. of Atmospheric Physics, Academy of Sciences, USSR). Space Sci. Rev., 3: 232-74(Aug. 1964).

Observations on the features, behavior, and occurrence of polar auroras are reviewed, together with interpretations proposed for the observations and theories advanced for polar auroras. 100 references. (D.C.W.)

5081 ARCTIC COMMUNICATIONS. Proceedings of the Eighth Meeting of the AGARD Ionospheric Research Committee, Athens, Greece, July 1963. B. Landmark, ed. Oxford, Pergamon Press, 1964. £5 Net. (Distributed in the Western Hemisphere by The Macmillan Company, New York). 305p. (AGARDograph 78)

Separate abstracts were prepared for seven of the 22 papers included. The remaining papers deal with ionospheric properties, radio wave propagation in polar regions, and polar communications. (D.C.W.)

For abstracts of individual papers see: 4823, 5082, 5083, 5084, 5085, 5086, and 5087.

5082 BACKSCATTER OBSERVATIONS AT LINDAU-HARZ WITH VARIABLE FREQUENCY DIRECTED TO THE AURORAL ZONE. H. G. Moeller (Max-Planck Institut für Ionosphärenphysik, Lindau-Harz, Ger.). p.177-88 of "Arctic Communications." Oxford, Pergamon Press, 1964.

Backscatter measurements were made using a sounder with variable frequency in order to observe from one point the variation of the ionospheric reflection conditions with distance and time. Backscatter traces due to sensitive reflections from field-aligned irregularities were observed. The path of the backscatter traces has a typical frequency dependence. The frequency dependence was calculated on

the assumption that backscatter would be possible only if the rays were bent in the normal F-layer so that they hit the irregularities at right angles. The results are in good agreement with the recorded traces. (D.C.W.)

5083 FIELD STRENGTH MEASUREMENTS OVER A 2000 KM SUBAURORAL PATH (SODANKYLA-LINDAU) COMPARED WITH THE ABSORPTION OBSERVED AT THE TERMINALS. Gerhard Rose (Max-Planck Institut für Ionosphärenphysik, Lindau-Harz, Ger.). p.189-203 of "Arctic Communications." Oxford, Pergamon Press, 1964.

Field strength measurements were performed over the 2000-km subauroral Sodankyla-Lindau path and, simultaneously, along two other lines: Norddeich-Lindau (300 km) and Kemi-Sodankyla (200 km). Using oblique ionograms obtained from the Sodankyla-Lindau line and the vertical ionograms of Sodankyla, Uppsala, and Lindau, the field strength recordings of undisturbed winter days were interpreted in terms of ionospheric D-region absorption. The results show that anomalous winter absorption appears all over the three lines. The relative intensity of the effect seems to increase with increasing latitude. (auth)

5084 VERY LOW FREQUENCY RADIO WAVES PROPAGATION AT HIGH LATITUDES. Alv Egeland and Willi Riedler (Kiruna Geophysical Observatory, Sweden). p.237-52 of "Arctic Communications." Oxford Pergamon Press, 1964.

The diurnal, seasonal, and yearly variations of the normal 16-kc/sec signal strength from the Rugby transmitter (φ = 52.4°N; λ = 1.2°W) were studied on the basis of data accumulated during approximately five years of continuous recording at the Kiruna Geophysical Observatory (φ = 67.8°N; λ = 20.4°E). The observations were interpreted in terms of a first-order mode theory. (D.C.W.)

5085 V.H.F.-BISTATIC-AURORA COMMUNICATIONS AS A FUNCTION OF GEOMAGNETIC ACTIVITY AND MAGNETIC LATITUDE. G. Lange-Hesse (Max-Planck Institut für Ionosphärenphysik, Lindau-Harz, Ger.). p.253-62 of "Arctic Communications." Oxford, Pergamon Press, 1964.

Observations of v-h-f bistatic aurora backscatter communications on 145 Mc/s within Middle Europe and from Middle Europe to Great Britain and Scandinavia covering the period from 1957 to the beginning of 1963 are analyzed with respect to the probability of occurrence of these phenomena as a function of the magnetic dip angle and the degree of geomagnetic activity. An interpretation is given of the results. (auth)

5086 OBSERVATIONS MADE BY THE IONOSPHERIC INSTITUTE OF ATHENS DURING THE SERIES OF NUCLEAR WEAPON TESTS AT NOVAJA ZEMLYA BETWEEN 10 SEPTEMBER AND 4 NOVEMBER 1961. M. Anastassiades, D. Ilias, G. Moraitis, and P. Giouleas. p.265-79 of "Arctic Communications." Oxford, Pergamon Press, 1964.

Ionospheric disturbances due to the nuclear explosions on October 23 and 30, 1961 were observed using a 30-kw peak ionospheric recorder and riometers. The explosion on October 30 was also recorded by microbarographs. The observations are described and interpreted. Increases in radioactive fallout corresponding to the Russian tests were also observed. (D.C.W.)

5087 OBSERVATION OF IONOSPHERIC PERTURBATIONS INDUCED BY NUCLEAR EXPLOSIONS. P. Halley, F. Biraud, and A. M. Bourdila. p.281-92 of "Arctic Communications." Oxford, Pergamon Press, 1964. (In French)

The ionospheric disturbances observed at distances of more than 1500 km from the site of an atomic explosion and its magnetic conjugate are described and interpreted. Russian tests at Nouvelle Zemble and American tests at Johnston Island are considered. (D.C.W.)

Low Temperature Physics

5088 (JUL-Bibl-4) TIEFTEMPERATURTECHNIK. ANLAGEN UND BAUELEMENTE FUR LEITUNG, TRANSPORT UND LAGERUNG, SPEZIELL VON FLUSSIGEM WASSERSTOFF, SOWIE TIEFTEMPERATUREIGENSCHAFTEN VON METALLEN, LEGIERUNGEN UND NICHTMETALLISCHEN WERKSTOFFEN. Eine Literaturzusammenstellung. (Low Temperature Technology. Installations and Devices for Management, Transport, and Storage of Liquid Hydrogen in Particular as Well as Low Temperature Characteristics of Metals, Alloys, and Non-Metallic Materials. A Literature Compilation). E. Paul, M. Wittenberg, and E. Freyschmidt (Kernforschungsanlage, Julich, Germany). Sept. 1964. 63p. Dep.(mn).

A total of 604 references is presented. Author and subject indexes are included. (D.L.C.)

5089 (TID-21324) STATISTICAL MECHANICS OF A CHARGED BOSON GAS (thesis). Technical Report No. 30. William Synjue Chow (Case Inst. of Tech., Cleveland). Dec. 1963. Contract AT(11-1)-623. 101p. Dep.(mn); $4.00(cy), 2(mn) OTS.

The Bohm-Pines method is applied to a charged boson gas immersed in a uniform canceling background charge for the purpose of separating out the plasmon collective modes. It is found that at $T \sim 0$, the low-lying excited states are phonon quasi-particle modes, and there should not be an energy gap between the single quasi-particle ground state and the low-lying excited states. The thermal properties at $T \sim 0$ were carried out straight-forwardly. With the effective-mass method, the excitation spectrum at $T \sim T_c$ (the condensation temperature) was found, and the condensation phenomenon was investigated. The present work centers around finding the relation between the cutoff wave number of plasmon modes and the density of the charged boson gas. A relation was found for $T \sim 0$. This relation is extended to the temperature region $T \sim T_c$, so that the thermal properties in this temperature region can be carried out. The theory for $T \sim 0$ can be in some way related to the theory of superconductivity; a comment on this is given. It shows that the present theory about the phonon quasi-particle excitations at $T \sim 0$ is very promising in explaining the experimental deviation of the specific heat of the superconducting phase at $T \sim 0$ from the prediction of the B.C.S. theory of superconductivity. (auth)

5090 SUPERCONDUCTING TUBES AND FILAMENTS. G. Arrhenius (Univ. of California, La Jolla), R. Fitzgerald, D. C. Hamilton, B. A. Holm, B. T. Matthias, E. Corenzwit, T. H. Geballe, and G. W. Hull, Jr. J. Appl. Phys., 35: 3487-90(Dec. 1964).

A study is reported of the superconductivity and microstructure that occur when small quantities of La are quenched with Rh in the arc furnace. A strikingly regular prismatic honeycomb of a superconducting compound is found when the La concentration is ≥0.5 at. %. For smaller concentrations a continuous network of the superconducting phase is no longer observed, which correlates with the lowering and broadening of the superconducting transition region. Evidence is given that for such low concentrations superconducting tunneling occurs through the elemental Rh phase itself thus pointing to the superconductivity of Rh at lower temperatures. (auth)

5091 SUPERCONDUCTIVITY OF HIGHLY AGGLOMERATED INDIUM FILMS. Arthur J. Learn and R. Spencer Spriggs (TRW Space Tech. Labs., Redondo Beach, Calif.). J. Appl. Phys., 35: 3507-11(Dec. 1964).

The conductive properties of indium films vacuum deposited at room temperature were examined in a shielded cryotron configuration for thicknesses up to 10,200 Å and temperatures down to 2.90°K. Due to agglomeration, films were conductive only for thicknesses exceeding a thickness t_c about 2000 Å for large rates of deposition and 5000 Å for small rates. For thicknesses t_b or greater, room-temperature resistivity was independent of thickness and had a value of 9.2 ± 0.3 μΩ-cm. Thickness t_b was about 2.5 and 1.5 t_c for high and low deposition rates, respectively. The superconductive critical temperature was 3.420° ± 0.005°K in the thickness range tested, 2200 to 10200 Å. Critical fields were described by the London theory with penetration depth having the temperature dependence suggested

by the Gorter–Casimir theory and value 700 ± 100 Å at 0°K. Film current for first appearance of resistance had a dependence on film thickness markedly different from any previously reported in the literature. This critical current exhibited a distinct peak at a thickness between t_c and t_b. The peak values agreed quantitatively with the London theory assuming width-independent current density and adopting a critical current density switching hypothesis. It was postulated that structure inhomogeneities served to maintain a uniformly distributed current on a macroscopic scale for certain thicknesses between t_c and t_b. (auth)

5092 PRESSURE-TEMPERATURE PHASE DIAGRAMS FOR Nb_3In AND Nb_3Bi. D. H. Killpatrick (Sandia Lab., Albuquerque, N. Mex.). J. Phys. Chem. Solids, 25: 1213-16 (Nov. 1964).

Using high-pressure high-temperature techniques pressure-temperature phase diagrams were constructed for Nb_3In and Nb_3Bi. This investigation resulted in the identification of a new metastable β-wolfram compound, Nb_3Bi, with a lattice parameter of $a_0 = 5.320$ Å. New body-centered cubic alloy phases were also identified in both systems. The superconducting transition for the Nb_3Bi was found to be 3.05°K. A hypothesis for the high pressure formation of these compounds is presented. (auth)

5093 STABILITY OF HELIUM(II) FLOW DOWN AN INCLINED PLANE. Din-Yu Hsieh (California Inst. of Tech., Pasadena). Phys. Fluids, 7: 1755-61(Nov. 1964).

The stability of a layer of helium II flowing down an inclined plane is investigated on the basis of the two-fluid theory. The expression of mutual friction is used in the analysis. Stability criteria are found for the limits in which essentially only the superfluid, or only the normal fluid, is present. In general, the flow system is stable only when the fluid layer is fairly thin. Then the system may be stable for certain intermediate compositions even when the fluid is flowing down the underside of the plane. The results may have some bearing on the problem of film flow in superfluid helium. (auth)

5094 ON THE SPECIFIC HEAT OF NIOBIUM IN THE MIXED STATE AT TEMPERATURES FAR BELOW THE TRANSITION TEMPERATURE. J. Ferreira da Silva, J. Scheffer, N. W. J. Van Duykeren, and Z. Dokoupil (Kamerlingh Onnes Laboratorium, Leiden). Phys. Letters, 12: 166(Oct. 1, 1964).

The specific heat of bundles of strained Nb wires is measured at 0.15 to 0.30 times the critical temperature. A contribution to the specific heat on the order of the normal specific heat is found in this temperature range. (T.F.H.)

5095 ON THE POSSIBILITY OF SUPERCONDUCTION IN GaN. A. Rabenau and T. J. Berben (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 12: 167(Oct. 1, 1964).

GaN samples are found to be non-superconducting at temperatures down to 2°K. The samples studied include stoichiometric transparent samples and nonstoichiometric colored samples. Temperatures below 2°K are not investigated. (T.F.H.)

5096 SUPERCONDUCTING TUNNELING FROM PURE LEAD ABOVE THE THERMODYNAMIC CRITICAL FIELD. Y. Goldstein (RCA Labs., Princeton, N. J.). Phys. Letters, 12: 169-70(Oct. 1, 1964).

The tunneling characteristics of Al–Pb tunnel junctions are measured at 1.4 to 4.2°K in magnetic fields above and below the thermodynamic critical field of Pb. The results are compared with models for Type I and II superconductors. (T.F.H.)

5097 ON THE HYSTERESIS IN THE PARALLEL FIELD TRANSITION OF SUPERCONDUCTING THIN FILMS. D. R. Tilley (Mullard Research Labs., Redhill, Surrey, Eng.). Phys. Letters, 12: 172-3(Oct. 1, 1964).

It is shown that the so-called "nucleation field" fits measurements of the magnetic field at which the superconducting phase appears in parallel-field transitions of thin films. That is, the nucleation field fits the critical field when the transition is second-order. (T.F.H.)

5098 ON THE FORCES WITHIN A SINGLE VORTEX-LINE IN A TYPE II SUPERCONDUCTOR. A. G. Van Vijfeijken and F. A. Staas (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 12: 175-6(Oct. 1, 1964).

The forces acting on a volume element of an electronic fluid in an extreme second-type superconductor, in which a single quantized vortex is generated, are investigated. It is pointed out that electrostatic forces as well as osmotic forces might be of importance. (T.F.H.)

5099 DIAMAGNETISM OF SURFACE SUPERCONDUCTIVITY. D. J. Sandiford and D. G. Schweitzer (Brookhaven National Lab., Upton, N. Y.). Phys. Letters, 13: 98-100(Nov. 15, 1964). (BNL-8448)

The magnetization curves of several samples of type-II Bi–Pb alloys were obtained at 4.2°K, and the properties of the residual magnetic moment observed above the second critical field H_{c2} were studied as a function of angular inclination to the magnetic field. The results indicate that the a-c diamagnetic behavior of type-II superconductors can be explained for all fields up to about H_{c3} in terms of diamagnetic hysteresis of the surface magnetic moment. (D.C.W.)

5100 ON SURFACE SUPERCONDUCTIVITY. V. L. Ginzburg (Lebedev Inst. of Physics, Moscow). Phys. Letters, 13: 101-2(Nov. 15, 1964).

The possibility of changing the interaction energy between electrons on or near the surface of metals and semiconductors by applying dielectric or monomolecular layers to the surface to permit observation of surface superconductivity is discussed. (D.C.W.)

5101 ROTATIONAL RELAXATION TIMES IN PARA-HYDROGEN. H. Zink, V. Van Itterbeek, and T. K. Bose (Institut voor Lage Temperaturen en Technische Fysika, Louvain, Belg.). Phys. Letters, 13: 131-2(Nov. 15, 1964).

The rotational relaxation times for para-hydrogen were determined as functions of temperature from measurements of the dispersion of ultrasonic waves at 77.5, 90.3, 273, and 293.6°K. The results were compared with other determinations. The relaxation time decreased with increasing temperature. The relation of the collision number to the relaxation time was also studied. (D.C.W.)

5102 MAGNETISATION CURVES OF SUPERCONDUCTING INDIUM LEAD ALLOYS IN A LONGITUDINAL AND A TRANSVERSE FIELD. W. F. Druyvesteyn (Philips Research Labs., Eindhoven, Netherlands). Phys. Letters, 13: 195-6(Dec. 1, 1964).

Magnetization curves of superconducting In–Pb alloys are reported, where the orientation between the axis of a thin wire and the field direction is varied. It is found that the upper critical field is independent of the orientation but that the irreversible part of the magnetization curves differ for different orientations. This is explained by means of a simple model. (C.E.S.)

5103 SUPERCONDUCTIVITY OF TELLURIUM. B. T. Matthias (Univ. of California, San Diego, La Jolla,) and J. L. Olsen. Phys. Letters, 13: 202-3(Dec. 1, 1964).

A superconducting transition in tellurium was observed under high pressure at about 3.3°K. (C.E.S.)

5104 SOME CALCULATIONS OF THE ACOUSTIC IMPEDANCE OF LIQUID He^3. G. A. Brooker (Oxford Univ.). Phys. Letters, 13: 224-6(Dec. 1, 1964).

Calculations of the acoustic impedance of liquid ^3He under its vapor pressure were made in order to interpret previous experimental results. (C.E.S.)

5105 MAGNETOTHERMAL EFFECTS IN TYPE II SUPERCONDUCTORS. N. H. Zebouni, A. Venkataram, G. N. Rao, C. G. Grenier, and J. M. Reynolds (Louisiana State Univ., Baton Rouge). Phys. Rev. Letters, 13: 606-9 (Nov. 23, 1964).

The temperature at different points of rods of pure Nb and Nb–Zr was recorded while the strength of an external magnetic field was decreased or increased linearly with time. Three distinct phenomena were observed in the mixed magnetic state for both decreasing and increasing fields and over the whole range of sweep rates (0.8 to 13.5 gauss/sec). An interpretation is proposed. (D.C.W.)

5106 TEMPERATURE AND PURITY DEPENDENCE OF THE SUPERCONDUCTING CRITICAL FIELD, H_{c2}. E. Helfand and N. R. Werthamer (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 13: 686-8 (Dec. 7, 1964).

A solution is given for the temperature and mean-free-path dependence of the upper critical field of a bulk, type-II superconductor. Spin paramagnetic effects are omitted. (C.E.S.)

5107 QUANTIZED VORTEX RINGS IN SUPERFLUID HELIUM. F. Reif. Sci. Am., 211: 116-22(Dec. 1964).

A series of experiments on the behavior of vortex rings in a nearly frictionless fluid is discussed. It is demonstrated that matter on a macroscopic scale can exhibit discrete quantum effects. (C.E.S.)

5108 SUPERCONDUCTIVITY IN V–Sc ALLOYS. N. V. Volkenshtein and E. V. Galoshina (Inst. of Physics of Metals, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 812-13(Sept. 1964). (In Russian)

The critical field and superconductivity transition temperature are determined in alloys containing vanadium and scandium (from 1 to 60% scandium). With an increase of the amount of scandium the superconductivity transition temperature increases up to 7.04°K. It is suggested that addition of scandium results in a shift of the Fermi surface towards higher state densities and hence to an increase of T_c. (auth)

5109 ELECTRODYNAMICS OF SUPERCONDUCTORS DIFFUSELY REFLECTING ELECTRONS FROM THEIR SURFACE. E. A. Shapoval (Moscow Aviation Inst.). Zh. Eksperim. i Teor. Fiz., 47: 1007-29(Sept. 1964). (In Russian)

A method is proposed for describing diffuse reflection of electrons from the surface of a metal in the case when the kinetic equation is inapplicable. The method is employed for developing the electrodynamics of finite size superconductors in a magnetic field on the basis of the BCS microscopic theory. The validity of the BCS result on the depth of penetration in diffuse reflection is demonstrated. Nonlinear effects (dependence of the energy gap and penetration depth on field strength) are considered throughout the whole temperature range. The limiting cases of absolute zero and of temperatures close to T_c are investigated in detail for London and Pippard superconductors. (auth)

5110 NONUNIFORM STATE OF SUPERCONDUCTORS. A. I. Larkin and Yu. N. Ovchinnikov (Inst. of Physics and Tech., Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1136-46 (Sept. 1964). (In Russian)

A ferromagnetic with Fermi surfaces separated at distances of the order of Δ goes over to the superconducting state in which Δ and spin density are periodic functions of the coordinates. The form of the crystal lattice produced by the electrons is found. The electromagnetic properties of this state and the excitation spectrum in it are investigated. (auth)

5111 THREE-CENTIMETER SUPERCONDUCTIVITY RESONATOR. B. I. Verkin, I. M. Dmitrenko, V. M. Dmitriev, G. E. Churilov, and F. F. Mende (Khar'kov Inst. of Physics and Tech.). Zh. Tekhn. Fiz., 34: 1709-11(Sept. 1964). (In Russian)

Descriptions are given of a superconducting three-centimeter resonator constructed from technical lead. The sensitivity of the resonator for E_{012} type oscillations is 5×10^6 at T = 4.2°K. The measurements of resonator efficiency and the uses of superconducting resonators are discussed. (tr-auth)

5112 IMPROVEMENTS IN OR RELATING TO CRYOGENIC DEVICES. Louis Bochirol, Jacques Doulat, and Louis Weil (to Commissariat à l'Énergie Atomique). British Patent 975,166. Nov. 11, 1964. Priority date July 27, 1962, France.

A device for low-temperature irradiation is described. The condensed cooling fluid returns to the cooling bath by gravity. A heater maintains the condensation surface temperature above the freezing point of the cryogenic fluid. (T.R.H.)

Neutron Physics

Refer also to abstract 4578.

5113 (CONF-446-79) MEASUREMENTS OF THE DIFFUSION PARAMETERS OF CARBON BLACK. E. Starr and J. W. L. Devilliers (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-1)-1480]. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The neutron diffusion parameters of carbon black were measured by the pulsed neutron technique. Decay constants were obtained for several geometric sizes, and the following parameters were derived: $\lambda_0 = 875 \pm 25$ sec^{-1}, $\overline{DV} = 2.814 \pm 0.017 \times 10^5$ cm^2/sec, $\sigma_s = 20 \pm 10$ barns, and C (diffusion cooling coefficient) = $100 \pm 5 \times 10^5$ cm^4/sec. (D.L.C.)

5114 (GA-5486) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending June 30, 1964. J. R. Beyster, W. Brouwer, J. U. Koppel, J. M. Neill, J. R. Triplett, J. A. Young, and J. C. Young (General Atomic Div., General Dynamics Corp., San Diego, Calif.). July 24, 1964. Contract AT(04-3)-167. 74p. Dep. (mn); $3.00(cy), 2(mn) OTS.

A new scattering kernel for D_2O was calculated including intramolecular interference. It appears that this representation does not fit experiment as well as the scattering kernel based on the incoherent approximation. Progress was made on the new scattering code GASKET during this quarter. Agreement was obtained between spectral measurements and theory for D_2O and H_2O under a variety of experimental conditions. A complete series of space dependent BeO spectra were measured and the pronounced effect of Bragg scattering was observed in the energy region near the cutoff. A similarly large effect is expected in poisoned steady state Be spectra. The angular cross-section measurements previously made in water were studied to ascertain the importance of multiple scattering. A new flight path was completed to eliminate many troublesome experimental difficulties as well as increase intensity by over an order of magnitude. Preliminary tests were completed and further measurements of the water scattering cross section at about 100 neutron energies from <0.01 to 5 ev are to be made. (auth)

5115 AN ITERATIVE METHOD FOR TREATMENT OF THE ENERGY-DEPENDENT TRANSPORT EQUATION. F. Laussermair. Acta Phys. Austriaca, 18: 146-58(1964). (In German)

The complete spatial, angular, and energy dependence of the neutron is treated in an iterative calculation that represents a simplification and expansion of the multigroup diffusion theory and one-group diffusion theory. In order to illustrate the characteristics of the differential equations derived, they were specialized to spherical and cylindrical coordinates. (J.S.R.)

5116 THEORY OF FERROMAGNETS WITH HELICOIDAL STRUCTURE. V. EFFECTS OF MAGNETIC FIELDS ON SCATTERING OF FAST NEUTRONS. V. N. Kashcheev (Inst. of Physics, Academy of Sciences, Latvian SSR). Acta Phys. Polon., 26: 11-17(July 1964). (In Russian)

Cross sections of elastic and single-spin magnetic scattering of monochromatic nonpolarized neutrons in a ferromagnet were studied as a function of a nonaxial magnetic field. Special studies were made of the area near phase

transitions to the collinear magnetic phase. An analysis was made of heuristic means for studying the functions (tr-auth)

5117 ON THE STATISTICAL MECHANICAL EVALUATION OF THE SLOW NEUTRON SCATTERING FUNCTION. A. Fuliński (Jagellonian Univ., Krakow). Acta Phys. Polon., 26: 19-30(July 1964).

A general statistical mechanical method of evaluation of the Van Hove scattering function describing the scattering of slow neutrons by many-body scatterers is presented. Techniques of perturbation expansion, diagram representation, and linked-cluster expansion, developed in the statistical-mechanical theory of irreversible processes are used. As an example of this method, the scattering function for a weakly coupled and a dilute gas, both obeying the classical statistics, is calculated. In this case it is possible to use almost directly some results obtained by Fujita in his calculation of the viscosity coefficients of such gases. (auth)

5118 COMPLEX BUCKLINGS IN THREE-GROUP THEORY. H. Heinrich (VEB Atomkraftwerk, Berlin). Kernenergie, 7: 634-5(Aug. 1964). (In German)

In the analytical solution of diffusion equations according to the three-group theory, three bucklings appear, which result from the roots of the cubic equation with unit matrix. The question of whether the appearance of complex bucklings must be taken into consideration in cases of physical interest was investigated. Calculations were made for water-moderated Zr-clad UO_2 fuel for various limits of epithermal groups and complex buckling was found for 0.2 to 10 and for 0.2 to 100 ev. (M.C.G.)

5119 FAST NEUTRON SPECTRUM OF Ra–Be SOURCE. B. B. Venkatapathi Raju and S. Jnanananda (Andhra Univ., Waltair, India). Nucl. Instr. Methods, 31: 87-9(Dec. 1, 1964).

The fast-neutron spectrum of the Ra–Be source has been taken up for study with a plastic crystal scintillation spectrometer employing the paraffin difference method. The spectrum extends up to 12 Mev with a broad peak at 4.5 Mev and peaks at 7.7 and 1.4 Mev, with indications of peaks at lower energies. This spectrum is similar to that of Po–Be source and is in agreement with the theoretically computed spectrum. (auth)

5120 A MODIFICATION OF THE KRIEGER-NELKIN APPROXIMATION IN THE THEORY OF SLOW NEUTRON SCATTERING. G. Kośaly and G. Solt (Central Research Inst. of Physics, Budapest). Phys. Letters, 13: 223-4 (Dec. 1, 1964).

The procedure of Krieger and Nelkin is an approximate version of the mass tensor approach to slow neutron scattering by molecules. The validity of the Krieger and Nelkin treatment is studied, and an improvement of the approximation is proposed. The scattering law is investigated for fixed momentum transfer as a function of the energy gain in the case of a rigid dumbbell-shaped molecule. (C.E.S.)

5121 HIGH RESOLUTION NEUTRON TRANSMISSION MEASUREMENTS OF THE 1148 ev RESONANCE OF NEUTRONS UPON Fe^{56}. R. C. Block (Oak Ridge National Lab., Tenn. and Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 13: 234-6(Dec. 1, 1964). (ORNL-P-301)

Transmission measurements were made upon 0.38 and 3.8 cm thick iron samples over a neutron energy range from 100 to 50,000 ev. These measurements were carried out at the 30-Mev electron linear accelerator laboratory. A resolution of about 3 ns/m (full-width-at-half-maximum) was achieved for these measurements by using the neutron-multiplying booster target, a time analyzer with 0.125 μ sec channel widths, a 93 meter flight path, and a (^{10}B–NaI) neutron detector. The 1148 ev resonance is assigned to p-wave neutrons. (C.E.S.)

5122 ON THE TOTAL REFLECTION OF NEUTRONS BY COBALT FILMS. D. Balli, B. Grabchev, M. Popeskeu, and M. Popovich (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 245-51(1964). (In Russian)

The total reflection of neutrons with a wavelength of 1.16Å on Co films between 700 and 1800Å in thickness was studied. The films were obtained by evaporation in the presence of a magnetic field. (tr-auth)

5123 DETERMINATION OF THE CAPTURE CROSS SECTION OF GRAPHITE BY THE PILE OSCILLATOR METHOD. A. Stefanescu, I. Iftode, M. Sabau, and C. Tapu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 365-71(1964).

The neutron capture cross section of graphite was determined by the pile oscillator method. The principle of the method is outlined, and the experimental system is described. The results are presented. (D.C.W.)

5124 REMARKS ON THE LIMITING CONDITIONS OF ASYMPTOTIC DIFFUSION THEORY. K. O. Thielheim (Christian-Albrechts-Universität, Kiel). Z. Physik, 181: 391-5(1964). (In German)

The diffusion theory can be considered as the attempt to describe transport processes in homogeneous media with assumption of a laboratory system of isotropic scattering laws, in an approximate way by differential equations $\{\Delta - 1/(\Sigma L)^2\}\,\varphi^{\mathrm{diff}}(r) = 0$ and suitable boundary conditions. The region of transport phenomena accessible by this description is naturally limited, however, it can be expanded considerably by careful selection of the boundary conditions. A simple process is explained, whose mathematical treatment was withheld from previously used numerical methods, but nevertheless, with recently suggested boundary conditions, is reproduced quite exactly by means of the diffusion theory. (tr-auth)

5125 NEITRONNAYA DOSIMETRIYA. (Neutron Dosimetry). M. F. Yudin and V. I. Fominykh. Moscow, Izdatel'stvo Gosudarstvennogo Komiteta Standartov, Mer i Izmeritel'nykh Priborov SSSR, 1964. 216p.

Neutron sources and their fundamental characteristics, basic processes in neutron interaction with matter and tissue, methods of measuring neutron currents and the apparatus used, and neutron dosimetry are discussed. 240 references. (IIC-M.G.)

Nuclear Properties and Reactions

Refer also to abstracts 4227, 4467, 4495, 4524, and 4579.

5126 (CEA-R-2408) CONTRIBUTION A L'ÉTUDE DU PROCESSUS DE LA FISSION THERMIQUE DE L'URANIUM-235. (Contribution to the Study of the Thermal Fission Process for Uranium 235). Mostafa Chahrtache (France, Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 86p. Dep.(mn).

Thesis submitted to Université, Paris.

The distribution of the masses of the fragments produced by the disintegration of ^{236}U formed when ^{235}U captures a thermal neutron was studied. The experimental method chosen consists in the simultaneous measurement—using p-n silicon junction detectors—of the energies of the two fragments emitted in coincidence. This measurement is first made by a conditioned analysis of the energy of one of the fragments and then by a two-dimensional analysis of the energies of the two fragments. Systematic results are obtained concerning the distribution of the masses for different values of the total kinetic energy. The five structures appearing both for the mass distributions and for the energies of the fragments are studied and discussed. Generally speaking, the results are in agreement with those obtained by the time-of-flight method. (auth)

5127 (INSJ-79) ANALYSIS OF THE HIGH-ENERGY JET SHOWERS. I. A PROPOSAL OF NEW KINEMATICS. Nobuo Yajima (Nagoya, Japan. Univ. Inst. of Plasma Physics) and Shun-ichi Hasegawa (Tokyo Univ. Inst. for Nuclear Study). Sept. 28, 1964. 26p. Dep.(mn).

A method is introduced for the kinematical analysis of data obtained from the study of multiple pion production at very high energy, without making use of a symmetry assumption for the angular distribution of pions in the center-of-mass system. Expressions are derived which, for constant and known transverse momentum of the emitted pions, gives the inelasticity in the mirror system, the four-momentum transfer, and the transverse momentum of the target particles. Introducing the asymmetry factor, which is obtainable appropriately in the practical case, it is shown to be possible to derive formulas which, also for constant and known pion transverse momentum, yield, in good approximation, the total energy and the angular momentum of the pions in the center-of-mass system, and the Lorentz factor of the center of mass. The formula for the Lorentz factor is compared with Castagnoli's formula, for the case in which a true asymmetry exists. (auth)

5128 (JINR-D-1798) THE MECHANISMS AND THE PRODUCTS OF THE REACTIONS BETWEEN COMPLEX NUCLEI. PART I. G. N. Flerov and V. A. Karnaukhov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 41p. (CONF-502-22). Dep. (mn).

From International Congress of Nuclear Physics, Paris, July 1964.

On the basis of extensive accumulated information, an analysis is made of the mechanisms of reactions with heavy ions: transfer reactions, reactions with the formation of a compound nucleus, and the decay of a compound nucleus with a large angular momentum. The specific features of the radioactive products of complex-nucleus interactions are also considered. In particular, the present status of the investigations concerning the proton decay of nuclei is discussed. (auth)

5129 (JINR-P-1801) SPONTANNO DELYASHCHIISYA IZOMER S PERIODOM POLURASPADA $0.9 \cdot 10^{-3}$ SEK. (Spontaneously Fissionable Isomer With Half Life of $0.9 \cdot 10^{-3}$ s). Yu. V. Lobanov, V. I. Kuznetsov, V. P. Perelygin, S. M. Polikanov, Yu. Ts. Oganesyan, and G. N. Flerov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 9p. Dep.(mn).

In bombarding plutonium and uranium by neon and boron ions accelerated at the 310-cm cyclotron there was found a spontaneously fissionable isomer with $Z \leq 99$ and half life equal to 0.85 msec. Glass detectors were used to record the spontaneous-fission fragments. (auth)

5130 (KFKI-15/1963) INVESTIGATIONS ON GAMMA-TRANSITIONS IN THE (2s1d) SHELL. I. Berkes, I. Demeter, I. Dézsi, Ilona Fodor, and L. Keszthelyi (Magyar Tudományos Akadémia Központi Fizikai Kutató Intézete, Budapest). 1963. 18p. Dep.(mn).

The excited levels in 2s1d shell nuclei, such as ^{20}Ne, ^{24}Mg, ^{27}Al, ^{28}Si, and ^{32}S, were studied because of twofold interest: the coupling in a nucleus in this range is usually neither pure LS nor jj and various intermediate coupling schemes are encountered from nucleus to nucleus; and the nuclei in the central region are deformed and exhibit collective properties. Properties of 32 nuclei are given. (R.E.U.)

5131 (KFKI-18/1963) MEASUREMENT OF ISOMERIC CROSS-SECTION RATIO FOR THE $Cs^{133}(n,\gamma)$ REACTION. I. Gulyás and Z. Zámori (Magyar Tudományos Akademia Központi Fizikai Kutató Intézete, Budapest). 1963. 9p. Dep.(mn).

The population ratio of the 4^+-spin ground state and the 8^--spin 137-kev isomeric state in ^{134}Cs produced by the activation of ^{133}Cs exposed to reactor neutrons was determined. The measured value of the ratio permits conclusions on the angular momentum distribution of the highly excited states in ^{134}Cs. (auth)

5132 (NP-14480) OPTICAL MODEL ANALYSIS OF NEUTRON ELASTIC SCATTERING FROM NITROGEN. B. Johansson (Sweden. Forsvarets Forskningsanstalt, Stockholm). Oct. 1964. 18p. Dep.(mn).

Optical model calculations of neutron scattering for ^{14}N were made. The energy region examined was 4.5 to 11.6 Mev. At lower energies, use was made of the Hauser-Feshbach formalism in order to estimate the compound elastic scattering. Reasonable fits were obtained, especially at higher energies. (auth)

5133 (NP-14500) DIE $N^{14}(d,\alpha)C^{12}$-REAKTION BEI 2-12 Mev DEUTERONENENERGIE (theses). (The $N^{14}(d,\alpha)C^{12}$-Reaction at 2-12 Mev Deuteron Energy (thesis)). Mohammad Anwar Chaudhri (Heidelberg, Germany. Universität). 1964. 53p.

The reaction $^{14}N(d,\alpha)^{12}C$ was investigated in the energy region from 2 to 12 Mev with semiconductor detectors. At 90, 135, and 165° the excitation functions for the three alpha groups which lead to the ground state, as well as the first excited states of ^{12}C, were measured. All curves showed strong resonance-like structure, which is assigned to the compound nucleus formation. The pertinent excitation energy in ^{16}O lay between 22 and 31 Mev. Most of the previously known ^{16}O levels in this energy region were reproduced; in addition many new levels could be determined. The absolute differential cross sections at 90° for the three alpha groups α_0, α_1, and α_2 amounted to 0.44 ± 0.05, 1.86 ± 0.20, or 0.21 ± 0.03 mb/st at 10 Mev deuteron energy. The angular distribution was also measured at 4, 6, 8, and 10 Mev. Its form changed plainly in the total energy region. This behavior, along with the structure of the excitation function, showed that compound nucleus formation plays an important roll in this reaction at the highest deuteron energies. (tr-auth)

5134 (TID-7705(p.231-9)) PROPERTIES OF LOW-ENERGY TRANSITIONS IN Dy^{161}. John D. Rogers (Copenhagen. Universitet. Institut for Teoretisk Fysik and California Inst. of Tech., Pasadena).

A duMond 2-m bent crystal spectrometer was used to study the decay of ^{161}Tb to ^{161}Dy. Results are given and a level scheme for ^{161}Dy is shown. (R.E.U.)

5135 A RE-DETERMINATION OF THE HALF-LIFE OF RUBIDIUM-87. A. Kovách (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 17: 341-51(1964).

The half life of ^{87}Rb was determined to be $4.77 \pm 0.10 \times 10^{10}$ yr using liquid scintillator methods. (D.C.W.)

5136 THE RENORMALIZABLE VECTOR BOSON THEORY OF WEAK INTERACTION. A. Frenkel and P. Hraskó (Central Research Inst. of Phyics, Budapest). Acta Phys. Acad. Sci. Hung., 17: 361-70(1964).

The predictions of a renormalizable vector boson theory, based on the boson propagator of Bialynicki-Birula, for the energy distribution of beta particles in allowed beta decay are compared with experimental observations. (D.C.W.)

5137 COMPETING DIRECT REACTIONS IN THE NUCLEAR STRIPPING REACTION. G. Adam and O. Hittmair. Acta Phys. Austriaca, 18: 159-65(1964). (In German)

The presence and strength of direct reactions that proceed parallel to a stripping reaction (d,p) and yield the same (equally excited) end nucleus were discussed. The symmetry of the (d,pγ) angular correlation was used as the distinguishing characteristic of these reactions (stripping, heavy-particle stripping, knock-out, and heavy-particle knock-out) when the direction of the gamma beam following the (d,p) reaction was measured. (tr-auth)

5138 PHOTON FISSION. F. Ehlotzky (CERN, Geneva). Acta Phys. Austriaca, 18: 266-71(1964). (In German)

The theory of photon fission is developed, and the proof of the law governing it is indicated. The special case of incident photon energies less than 1 Mev is considered. (J.S.R.)

5139 THE POSITRON SPECTRUM OF F^{18}. I. Hofmann (Osterreichische Studiengesellschaft für Atomenergie, Vienna). Acta Phys. Austriaca, 18: 309-14(1964). (In German)

The positron spectrum of ^{18}F was measured as accurately as possible, and the shape of the spectrum was

investigated using the shape factor. The preparation of the source and the measurement method were described. The positron decay proceeds 97% from the (1+) level of ^{18}F to the (0+) level of ^{18}O. It is $\Delta J = -1$, $\Delta\pi = 0$ (parity conserved), and $\Delta T = +1$. The positron decay must, therefore, be a pure Gamow-Teller transition and the spectrum must have a permitted form. The log ft value of 3.6 corresponded to a super-permitted decay. The shape factor diagram is given and is constant within the limits of error. (J.S.R.)

5140 THE LOW-ENERGY BETA SPECTRUM OF Ar^{41}. Helmut Paul (Osterreichische Studiengesellschaft für Atomenergie, Vienna). Acta Phys. Austriaca, 18: 315-19(1964). (In German)

Measurements on the spectral form of ^{41}Ar at low energies were reported. The sample preparation and measurement method were described. The corrections to the counting rate and the results were tabulated. An end point energy of 1198.3 ± 1.1 kev was obtained, together with $Q_\beta = 2489 \pm 2.7$ kev. The shape factors fall at higher energies and, in the range from 80 to 1140 kev, are compatible with the form $S = 1 - (0.017 \pm 0.005)W$. (J.S.R.)

5141 ALPHA PARTICLES AND HEAVIER FRAGMENTS EMITTED DURING NUCLEAR REACTIONS. Marc Lefort (Faculte des Sciences, Orsay, France). Ann. Phys. (Paris) (13), 9: 249-69(May-June 1964). (In French)

The two-stage model for the emission of alpha particles and heavier fragments during nuclear reactions is examined on the basis of available data. The emission of helium ions, which seems to fall within the framework of the two-stage mechanism, is first briefly considered. Recent results on the emission of alpha particles that seem relevant to the concept of alpha substructures are considered. The observations of fragments heavier than He in cosmic-ray reactions and in reactions of accelerator beams are reviewed as an introduction to recent studies that yield information on the "fragmentation process." The data that suggest most strongly a fragmentation process are reviewed. 62 references. (J.S.R.)

5142 STUDY OF THE LIGHT NUCLEI ^{26}Al AND ^{10}B. J.-Cl. Bizot (Faculte des Sciences, Paris). Ann. Phys. (Paris) (13), 9: 421-70(July-Aug. 1964). (In French)

The excited states of ^{26}Al and ^{10}B were studied by the analysis of γ spectra released by the capture resonance of protons by ^{25}Mg and ^{9}Be. The bombardment energies were between 1 and 2 Mev. The decay mode of the 2.36 and 3.07-Mev levels were established, and the decay modes of the 2.70, 2.91, and 5.13-Mev levels were given with a lesser degree of certainty. The value of the spin of the 2.36-Mev level was also established. The γ spectra given by 24 resonances between 0.990 and 1.9 Mev were presented. The characteristics of the 6.89-Mev level of ^{10}B were determined. (J.S.R.)

5143 HYPERFRAGMENTS PRODUCED IN THE INTERACTIONS OF 25-Gev PROTONS, 17.2-Gev/c π^- MESONS, AND 1.5-Gev/c K^- MESONS WITH NUCLEI OF IONOGRAPHIC EMULSIONS. Germain Baumann (Centre de Recherches Nucleaires, Strasbourg). Ann. Phys. (Paris) (13), 9: 471-543(July-Aug. 1964). (In French)

The properties and different decay modes of hyperfragments are analyzed. The experimental method used in the study of the production of hyperfragments is described. The experimental results on the hyperfragments produced in the interactions of 25-Bev protons, 17.2-Bev/c mesons (π^-), and 1.5-Bev/c mesons (K^-) and the emission of the nuclear fragments ^{8}Li and ^{9}Be in these interactions are reported. An interpretation of these experimental results is given. (J.S.R.)

5144 THE REACTION $3He^4 \rightarrow C^{12}$. G. Paquette and H. Reeves (Univ. of Montreal). Astrophys. J., 140: 1319-22 (Oct. 1, 1964).

The ratio of excited carbon nuclei to helium nuclei in the reaction $3\,^4He \rightarrow {}^{12}C$ is derived by means of both the reaction-rate theory approach and the statistical-mechanics approach. (C.E.S.)

5145 CALCULATIONS OF THE MAXIMUM YIELDS OF DELAYED NEUTRONS PRODUCED BY CERTAIN PHOTONUCLEAR REACTIONS. M. M. Dorosh, Ya. E. Kostyu, and V. A. Shkoda-Ul'yanov. At. Energ. (USSR), 17: 215-17 (Sept. 1964). (In Russian)

Expressions for delayed neutron emission from infinitely thick samples are derived using Belen'kii-Tamm equilibrium spectrum. Curves of neutron emission vs energy are given for ^{238}U, ^{232}Th, and for H_2O calculated from data on the ^{18}O (γ,p) cross section. (M.J.T.)

5146 FISSION OF ^{238}U BY 26.5 Mev α-PARTICLES. B. A. Bochagov, S. S. Vasil'ev, G. G. Semenchuk, and G. E. Solyankin. At. Energ. (USSR), 17: 219-20(Sept. 1964). (In Russian)

A formula expressing the kinetic energy of fission fragments in terms of their mass ratio was proposed previously. The assumption that the decrease of a constant in this formula is associated with the momentum carried into the nucleus by the fissioning agent is tested. The kinetic energies of fragments from the fission of ^{238}U by 26.5-Mev α particles were studied, using semiconductor surface-barrier detectors. The measured fragment energy vs mass ratio is presented and compared with the calculated curve and with previous experimental and calculated values for thermal-neutron fission of ^{241}Pu; results confirm the assumption. (M.J.T.)

5147 A NEUTRON CHOPPER AT THE FRG I FOR MEASUREMENTS OF TOTAL NEUTRON CROSS SECTIONS. G. Richter and E. Bagge (Universität, Kiel). Atomkernenergie, 9: 307-20(Sept.-Oct. 1964). (In German)

A time-of-flight spectrometer with a flight path up to 60 m was installed at the Research Reactor Geesthacht. The spectrometer is patterned after that of the Brookhaven chopper. Two rotors are available, both of which are equipped with parallel slits, 0.03 and 0.16 cm wide. The diameter of both rotors is 25 cm. Each contains two perpendicular groups of slits with five parallel channels each. Thus four neutron bursts are produced per revolution. For the neutron-stopping material lucite was selected. It is supported by two high-strength disks of aluminum. To withstand the centrifugal forces, the stopping material is assembled from several pieces. The balanced rotor hangs on a 0.28-cm-thick, 16-cm-long rod of flexible steel. Movements of the pendulum are damped by a weight. The rotor spins in vacuum to avoid friction. The moment of rotation is carried to the flexible shaft by a rotating vacuum seal. The maximum rotor speed is 9000 rpm. The zero-time signal to the time analyzer is provided by a photoelectric device. The detectors at the end of the flight path are BF_3 counters. For the measurements of flight times a 4096-channel time-of-flight analyzer is used. The first experiments were performed with a 13.3-m flight path. For testing the chopper facility the transmission of a 0.32-mm-thick indium foil and a 0.5-mm-thick gold foil were measured in the energy range $1.5 \leqq E \leqq 10$ ev. The two located transmission dips of indium were in good agreement, within the limit of error, with the known resonances of indium at 3.68 and 9.1 ev. The measured transmission curve of the gold foil also agreed with the calculated transmission. For these calculations the known cross sections of gold in the energy range of interest were used. After these test measurements the transmission of a 29-mm-thick probe of palladium was investigated. Besides transmission dips by the known resonances at 13.2, 25.4, and 33.1 ev, dips at 4.89 and 2.95 ev were found. While it can be shown, that the minimum of transmission at 4.89 ev is produced by an impurity of gold, it can be assumed, that the transmission dip at 2.95 ev must be assigned to a resonance of palladium. To evaluate measurements obtained by time-of-flight spectrometers, it is necessary to know the resolution function as exactly as possible. Also the finite opening time of rotor slits, the finite channel time of the time analyzer, and the jitter of the counters must be considered, as well as the influence of the divergence of the neutron beam, the transmission of the stopping material, and the finite geometry of the detectors. The influence of these factors on the accuracy of the time-of-flight measurement was calculated

and the resolution function of the used chopper operation was approximated by a Gaussian function. From the calculation the known possibilities to improve the facility by means of "cigar-shaped" slits, split detectors, or double-rotor arrangements could be deduced. (auth)

5148 CALCULATION OF THE ANISOTROPIC ELASTIC SCATTERING OF FAST NEUTRONS FOR SOME STRUCTURE AND SHIELDING MATERIALS. F. Buehler and D. Emendoerfer (Technische Hochschule, Stuttgart). Atomkernenergie, 9: 321-5(Sept.-Oct. 1964). (In German)

Differential elastic cross sections for Al, Fe, Zr, and Pb were calculated for neutron energies between 2 and 14 Mev with the optical model. Compound elastic scattering was taken into account. The parameters of the local potential are discussed. An expansion in spherical harmonics was carried out for the cross sections and its coefficients were tabulated as a function of energy. (auth)

5149 POLARIZATION IN DIRECT NUCLEAR INTERACTIONS. M. El-Nadi and H. Fahmy (Cairo Univ. and Atomic Energy Establishment, Cairo). Atomkernenergie, 9: 327-34(Sept.-Oct. 1964).

The polarization of outgoing nucleons in direct nuclear reactions is considered. Distortion of the outgoing and incoming particle waves is assumed. A spin-dependent potential is responsible for the distortion of the outgoing particle and a spin independent potential for the incoming particle. The polarization of outgoing neutrons in (p,n) reactions according to the distorted direct-reaction theory was calculated. The method was then applied to some experimental data for $T(p,n)^3He$ reaction, and the numerical values of the parameters of the distorting potentials that give good fitting were derived. (auth)

5150 NUCLEAR REACTIONS. Manuel Tellería Marqués. Bol. Junta Control Energia At. (Peru), 9: No. 48, 15-24(Jan.-Mar. 1964). (In Spanish)

The formula for the energy produced in nuclear reactions is given and discussed. The difference between natural and artificial radioactivity is illustrated, and fission and fusion reactions are described. (J.S.R.)

5151 ON THE APPLICATION OF THE RARE GASES RADIOLUMINESCENCE INCREASE BY THE ELECTRIC FIELD FOR THE STUDIES OF INELASTIC SCATTERING OF ELECTRONS. A. Szymański and M. Kryszewski (Technical Univ., Lodz, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 507-11(1964).

Calculations were made on the increase of radioluminescence intensity in gas mixtures. This increase is shown to be related to such factors as the cross section for inelastic scattering of electrons, the position of the excitation level, the concentration of the molecular gas impurity, the strength of the electric field, and the pressure. (M.C.G.)

5152 COUPLING CONSTANTS BETWEEN NUCLEI IN NUCLEAR MAGNETIC RESONANCE. Jean-Claude Muller (Université, Nancy). Bull. Soc. Chim. France, No. 8, 2027-32(Aug. 1964). (In French)

The different values of coupling constants between nuclei, published since January 1961, were compiled. In the case of coupling between protons, the effect of the structure of the body in which these protons come into play, of their relative position in the substance considered, and of different substituents in the same series of derivatives was established. The coupling between a proton and another nucleus and the effect of the structure of the substance studied on the value of the coupling constant were then discussed. Various references relative to the values of the coupling constants between nuclei other than protons were added. 185 references. (tr-auth)

5153 COUPLING BETWEEN NUCLEAR SPINS IN NUCLEAR MAGNETIC RESONANCE (NMR) AND THE DOUBLE RESONANCE METHOD. Joseph Parello (CNRS, Gif-sur-Yvette, France). Bull. Soc. Chim. France, No. 8, 2033-62(Aug. 1964). (In French)

A bibliographic review is given of the current experimental and theoretical data on coupling between nuclear spins in NMR and the double resonance method. The relation between the coupling constant and molecular structure is not considered. The aspect of spectra predictable from certain values of the coupling constant and chemical displacements is discussed. The physical characteristics of coupling between nuclear spins are indicated. A description is then given of two nuclei coupled with a constant J_{12}. The theory and applications of double resonance are described. 92 references. (J.S.R.)

5154 LOW-ENERGY ELECTRON SPECTRUM EMITTED DURING TRANSMUTATION OF TUNGSTEN 187 TO RHENIUM 187. Claire Sebille and Francois Widemann (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France). Compt. Rend., 259: 2207-10 (Oct. 5, 1964). (In French)

The electron spectrum emitted during the transmutation $^{187}W \rightarrow {}^{187}Re$ in the energy interval from 23 to 135 kev was studied with the aid of two semi-circular magnetic spectrographs with and without preacceleration. The existence of numerous new conversion rays was established. (tr-auth)

5155 NUCLEAR ENERGY LEVELS IN Fe^{56} AND THE ROTATIONAL MODEL. P. C. Sood and Raj K. Gupta (Panjab Univ., Chandigarh, India). Indian J. Pure Appl. Phys., 2: 301-2(Sept. 1964).

The interpretation of nuclear energy levels of ^{56}Fe on the rotational model is discussed. The energies of the levels in excited rotational bands based on the gamma-vibrational states are calculated using the rotation-vibration coupling constant derived from the band head energy. The agreement between the predicted values and the experimental results is good. The possible existence of a beta vibrational excited band is discussed. (auth)

5156 RADIOACTIVE DECAY OF Nd^{147} AND Tb^{160}. V. V. G. Sastry, V. Lakshminarayana, and Swami Jnanananda (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 2: 307-12(Oct. 1964).

The decay of ^{147}Nd and ^{160}Tb was studied using a sum coincidence spectrometer of the fast-slow type. In the decay of ^{147}Nd previously unreported gamma components at 182, 351, 508, and 723 kev were observed. The 182-kev level suggested by Wendt is supported by the present studies. Along with other energy levels which are already well established, the energy level at 723 kev proposed by Gunye is also confirmed, and its decay mode is observed to be by a crossover transition to the ground state. In ^{160}Dy the results indicate that introducing an energy level at 1554 kev is more appropriate than at 1487 kev, as suggested by Naqvi. Also, the results favor an energy level at 1200 kev rather than at 1287 kev as proposed by Ewan. The decay modes of these and other higher energy levels were studied, and energy level schemes for both ^{147}Pm and ^{160}Dy incorporating the results of the present investigation were obtained. (auth)

5157 STUDY OF THE NEUTRONS PRODUCED ON DEUTERON BOMBARDMENT OF LITHIUM. M. K. Saxena and J. P. Sah (Lucknow Univ., India). Indian J. Pure Appl. Phys., 2: 364-5(Nov. 1964).

The neutron spectrum of the (Li,d) reaction was studied by subjecting a 68-kev thick lithium target to a beam of 500-kev deuterons. Over 3000 proton tracks recorded on G5 nuclear research plates (emulsion thickness, 400 μ) mounted at angles of 0, 45, 60, 90, 120, 135, and 150° to the direction of the deuteron beam were analyzed. The energy values of the recoil protons were converted to Q-values of the neutron spectrum. The histograms obtained by adding the Q-values of the spectra at different angles of observation indicate the existence of only the ground state and the energy level corresponding to 2.9 Mev. The angular distribution of the neutrons shows a pronounced maximum in the forward direction (auth)

5158 THE MEASUREMENT OF THE NEUTRON FISSION CROSS SECTION OF ^{240}Pu IN THE ENERGY RANGE 60–500 kev. P. Ruddick and P. H. White (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. A & B, 18: 561-7(Oct. 1964).

The neutron fission cross section of ^{240}Pu was measured relative to that of ^{235}U in the energy range from 60 to 500 kev. The cross section rises from a mean value of 75 ± 7 mb below 160 kev to 286 ± 54 mb at 485 kev. The results were compared with earlier measurements. (auth)

5159 ANGULAR MOMENTUM OPERATOR OF THE GENERALIZED RANK. Z. Rudzikas, A. Bandzaitis, J. Vizbaraite, and A. Jucys (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR and Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 5-12(1964). (In Russian)

The many-fold tensor products of the angular momentum operator are considered. The connection of this operator with the unit tensor operator of Racah is given. With the aid of the operators under consideration the operators giving the selection rules for the transitions between the states of the same configuration are constructed. (auth)

5160 INTENSITY, BACKGROUND AND RESOLUTION WIDTH IN NUCLEAR COUNTING EXPERIMENTS. G. Quittner (Oesterreichische Studiengesellschaft für Atomenergie, GmbH, Seibersdorf, Austria). Nucl. Instr. Methods, 31: 61-7(Dec. 1, 1964).

Some formulas for the evaluation of nuclear counting experiments with regard to their statistical accuracy are developed. Three types of measurements are considered: simple counting; location measurements; and intensity distribution measurements. Finally, the relation of the statistical uncertainty to other sources of error is discussed briefly, leading to the matching principle. Examples are drawn mainly from the field of inelastic scattering of thermal neutrons. (auth)

5161 PARTIAL WAVE ANALYSIS OF THE (p,2p) REACTION. Daphne F. Jackson (Battersea Coll. of Tech., London and Univ. of Washington, Seattle) and Tore Berggren. Nucl. Phys., 62: 353-72(Feb. 1965).

An investigation of the effect of distortion in the (p, 2p) reaction is made. A partial wave treatment of the distorted waves is used and a comparison made with results obtained using WKB approximation for the distorted waves for the particular case of the ^{6}Li (p, 2p) reaction with 185-Mev incident protons. The formalism of the partial wave method is considered in some detail and is shown to reveal the symmetries of the process more clearly than other methods. The problems involved in treating the three-body system in the final state are also discussed. (auth)

5162 COULOMB WAVE THEORY OF STRIPPING. Fernando B. Morinigo (California Inst. of Tech., Pasadena). Nucl. Phys., 62: 373-84(Feb. 1965).

An exact analytic treatment of pure Coulomb distortions in stripping reactions is presented. This first-order theory is analogous to some of the simplest plane-wave theories; the important innovation consists in the use of pure Coulomb waves instead of plane waves to describe the relative motions in both entrance and exit channels. The projectile is considered to be a bound state of two particles, described by a purely asymptotic wave function of the form $e^{-\alpha r}/r$. The resultant nucleus is considered to be a bound state of the target particle plus a captured particle, described by a wave function of definite orbital angular momentum L, with a radial part which may be taken to be any linear combination of terms of the form $r^{L}e^{-\beta r}/r$. The distorted-wave cross sections predicted are found to contain a factor whose leading term has an angular variation identical to that predicted by the analogous plane wave theory. A second factor, which is identical for all values of L, depends only on the energies and the Coulomb parameters of the relative motions; it represents the overall decrease in magnitude due to the Coulomb repulsions in both incident and exit channels. A third factor contains an additional angular dependence due to the distortions. The angular dependence is found to resemble qualitatively the angular dependence of plane wave theories except possibly in the case that the Coulomb parameters are very large in the entrance and the exit channels simultaneously. Detailed formulas are given for cases of L = 0, L = 1, and L = 2. These are so simple that there should be no point in using plane-wave expressions, rather than these Coulomb-wave expressions, for the preliminary evaluation of experimental results showing the usual characteristics of stripping. (auth)

5163 COULOMB EXCITATION OF Ti^{50}, Cr^{52}, AND Fe^{54} FIRST EXCITED STATES. J. J. Simpson (Oxford Univ.), J. A. Cookson, D. Eccleshall, and M. J. L. Yates. Nucl. Phys., 62: 385-92(Feb. 1965).

The first excited states of the even N = 28 nuclei, ^{50}Ti, ^{52}Cr, and ^{54}Fe were Coulomb excited using oxygen ions. The elastic and inelastic oxygen groups were observed at 90° using a magnetic spectrograph, and the E2 transition strengths were deduced from the ratio of the intensities of the two groups. The B(E2; $0^{+} \rightarrow 2^{+}$) values, 0.024 ± 0.002, 0.048 ± 0.002, and 0.051 ± 0.002, obtained for ^{50}Ti, ^{52}Cr, and ^{54}Fe, respectively, are compared with a theory due to Kisslinger and Sorensen. (auth)

5164 REACTION CROSS SECTIONS FOR 26.5 Mev DEUTERONS. S. Mayo (Comision Nacional de Energia Atomica, Buenos Aires), W. Schimmerling, M. J. Sametband, and R. M. Eisberg. Nucl. Phys., 62: 393-400(Feb. 1965).

By using an attenuation technique, total reaction cross sections were measured for 26.5-Mev incident deuteron energy on Be, C, Mg, Al, Ti, V, Fe, Ni, Co, Cu, Zn, Zr, Rh, Ag, Sn, Ta, Au, and Pb. The main feature of the data is the presence of a minimum in the nickel region in agreement with surface absorption optical model calculations performed on elastic scattering data at 27.5 Mev. In general surface absorption calculations predict σ_R values in better agreement with experimental data than volume absorption calculations. (auth)

5165 RELATIVE INTENSITIES AND ENERGIES OF THE K AUGER ELECTRONS IN Br^{79}. P. Erman (Research Inst. for Atomic Physics, Stockholm), I. Bergstroem, Y. Y. Chu, and G. Emery. Nucl. Phys., 62: 401-9(Feb. 1965). (BNL-8365)

It was possible to observe all nine components of the KLL Auger group of ^{79}Br in a double focusing beta spectrometer at an electron line width of about 0.08%. A source of ^{79}Kr prepared by electromagnetic separation was used. Except in the case of $KL_IL_I(^1S_0)$ the relative energies were found to be in good agreement with the semi-empirical results of Hörnfeldt which are based on non-relativistic calculations including intermediate coupling by Asaad and Burhop. Comparison of the relative intensities of the KLL components, normalized to $KL_IL_I(^1S_0)$, with the calculations of Asaad and Burhop, shows that the experimental intensities are considerably larger than predicted. This is especially the case for the three so called satellite lines $KL_IL_{II}(^3P_0)$, KL_IL_{III} $(^3P_2)$ and $KL_{III}L_{III}(^3P_0)$. (auth)

5166 THE $Mg^{25}(d,\alpha)Na^{23}$ REACTION AT LOW ENERGY. V. Y. Gontchar, M. H. S. Bakr, and H. M. Omar (Atomic Energy Establishment, Cairo). Nucl. Phys., 62: 410-16(Feb. 1965).

Energy spectra of α particles from the reaction ^{25}Mg(d,α) ^{23}Na for ten energies in the range 1.5−2.5 Mev at backward angles were investigated. Relative intensities of the α groups are discussed in the light of the 2J + 1 rule. Using this rule the existence of a doublet at 3 Mev with assigned spin values are suggested. (auth)

5167 ENERGY LEVEL STRUCTURE OF Sc^{42}. J. W. Nelson, J. D. Oberholtzer, and H. S. Plendl (Florida State Univ., Tallahassee). Nucl. Phys., 62: 434-48(Feb. 1965).

Threshold measurements of the beta decay activity from the residual nucleus in the reaction ^{39}K(α,n)^{42}Sc yield a ground state Q value of −7.455 ± 0.030 Mev and energy levels of ^{42}Sc at 0.526 ± 0.020, 0.600 ± 0.030, 1.34 ± 0.030, 1.42 ± 0.030, 2.22 ± 0.030, 2.96 ± 0.030, and 3.57 ± 0.040 Mev. Positon end-point energies calculated from threshold values are 5.525 ± 0.030 Mev for the superallowed decay of the ^{42}Sc ground level to the ^{42}Ca ground level and 2.820 ± 0.030 Mev for the allowed decay of ^{42m}Sc to the 3.191-Mev

level of ^{42}Ca. The total cross section is 2.2 ± 0.2 mb for the ^{39}K(α,n)^{42}Sc reaction and 6.6 ± 0.6 mb for the ^{39}K(α,n) ^{42m}Sc reaction at alpha-particle energies 1.45 Mev above the respective thresholds. The half life is 0.65 ± 0.01 sec for the superallowed decay and 60.6 ± 0.4 sec for the allowed decay. The experimental levels compare reasonably well with those predicted by a jj coupling shell model. The energy difference between the isomeric levels of ^{42}Sc is in accord with a systematic tendency of the energy difference between the lowest T = 0 and T = 1 levels in odd nuclei with N = Z. (auth)

5168 STUDY OF MU-MESONIC X-RAYS. ELEMENTS FROM RHODIUM TO URANIUM. G. Backenstoss (CERN, Geneva), K. Goebel, B. Stadler, U. Hegel, and D. Quitmann. Nucl. Phys., 62: 449-76(Feb. 1965).

The energies of the μ-mesonic 2p-1s transitions and differences of these energies were measured for 19 elements between rhodium and uranium. The apparatus, the experimental procedure, and the data analysis are described in detail. The measured 2p-1s energies agree with those calculated under the assumptions of a constant maximum density of the nuclear matter and a constant surface thickness for the elements studied. For europium and gadolinium a broadening of the 2p-1s transition, probably due to quadrupole interaction, is observed. The K_α and L_α spectra of lead and bismuth were measured especially carefully, and the spin doublet components were analyzed for their spacing and intensity ratio. (auth)

5169 THE QUADRUPOLE INTERACTION OF 2p-DOUBLETS IN MUONIC ATOMS WITH HEAVY DEFORMED NUCLEI. H. L. Acker (Universität, Freiburg, i. B.), H. Marschall, G. Backenstoss, and D. Quitmann. Nucl. Phys., 62: 477-90(Feb. 1965). (In German)

The measurements of mu-mesonic 2p-1s transitions in the nuclei ^{238}U and ^{232}Th revealed for the first time an effect due to the quadrupole interaction between the nucleus and the muon. The comparison of theoretical calculations with the experimental results shows that the characteristic differences between these spectra and those of atoms with spherical nuclei originate from the quadrupole interaction. The improvements of these calculations compared with the theory of Wilets consist in the consequent consideration of nuclear size effects and in a detailed discussion of the population of the mu-mesonic 2p levels. It was further possible to determine the sign of the intrinsic quadrupole moment which was found to be positive for both ^{238}U and ^{232}Th nuclei. (auth)

5170 THE THERMAL NEUTRON CAPTURE CROSS SECTION OF A NATURAL BORON. S. A. R. Wynchank, A. E. Cox, and H. Collie (Oxford Univ.). Nucl. Phys., 62: 491-6(Feb. 1965).

The thermal neutron capture cross section σ_B of a natural boron was obtained by a pulsed-neutron method with an effectively infinite tank, containing solutions of boric acid. Measurements were made in pure water and four different solutions of boric acid. The variation of decay constant with boron density is linear and its slope gives σ_B. The sample of boric acid was taken from the new AERE, Harwell boron standard. The result obtained was σ_B = 760.1 ± 1.5 b. (auth)

5171 ELASTIC AND INELASTIC SCATTERING OF 6 Mev NEUTRONS. R. M. Wilenzick, K. K. Seth, P. R. Bevington, and H. W. Lewis (Duke Univ., Durham, N. C.). Nucl. Phys., 62: 511-25(Feb. 1965).

Angular distributions of the elastic and inelastic scattering of 6-Mev neutrons from carbon and seven heavy nuclei were measured at 10° intervals between 20 and 150° using a pulsed-beam time-of-flight technique. The elastic scattering angular distributions were successfully fitted with the predictions of the non-local optical-potential model of Perey and Buck. The inelastic scattering angular distributions are spherically symmetric in agreement with the predictions of the compound nucleus model. An estimate of 10 ± 5% is obtained for the direct interaction contribution. (auth)

5172 ANALYSIS OF RESONANCE PARAMETERS OF COBALT FOR NEUTRONS OF ENERGY BELOW 30 kev. J. Morgenstern, G. Bianchi, C. Corge, V.-D. Huynh, J. Julien, F. Netter, C. Le Poittevin, and M. Vastel (Centre d'Etudes Nucléaires, Saclay, France). Nucl. Phys., 62: 529-40(Feb. 1965). (In French)

The total neutron cross section of ^{59}Co was measured with a resolution of 0.8 ns/m up to an energy of 60 kev. The parameters of the resonances below 30 kev were determined by means of the single-level Breit-Wigner formula using a shape analysis. The value of the s-wave neutron strength function $\overline{\Gamma_n^0}/D$ is found to be (6.7 ± 3.3) × 10^{-4} $ev^{-½}$ for the state J = 3 and (3.3 ± 1.4) × 10^{-4} $ev^{-½}$ for the state J = 4. The value of the potential scattering length is found to be 4.9 ± 0.5 fm for the state J = 3 and 5.8 ± 0.5 fm for the state J = 4. (auth)

5173 NUCLEAR STRUCTURE STUDIES OF Tl^{206} WITH Tl^{205}(d,p) REACTIONS. Paresh Mukherjee (Univ. of Pittsburgh and Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., 62: 541-7(Feb. 1965).

Several energy states of ^{206}Tl (up to 5.4 Mev) are located with (d,p) reactions on isotopically enriched (99%) ^{205}Tl. From the (d,p) cross sections for exciting the 0^- ground state in ^{206}Tl, it is found that the ground state of ^{205}Tl is about $74\%(s_{½})_p^{-1}(p_{½})_n^{-2}$, which agrees well with the theoretical estimate. The $(s_{½})_p^{-1}(p_{½})_n^{-1}$ splitting in ^{206}Tl is found to be 0.29 Mev. The low-energy proton excitation spectra have a close similarity with the ^{208}Pb (d,p) proton spectra, so that the $g_{9/2}$, $d_{5/2}$, and $s_{½}$ neutron states can be identified in ^{206}Tl. (auth)

5174 SPIN-ORBIT EFFECTS IN THE Ne^{20}(d,nγ)Na^{21} REACTION. W. R. Gibbs (Univ. of Neuchâtel, Switzerland and Los Alamos Scientific Lab., N. Mex.) and W. Grueebler. Nucl. Phys., 62: 548-60(Feb. 1965). (LADC-6269)

A study was made of the ^{20}Ne(d,nγ)^{21}Na reaction to see if compound nucleus and distortion effects could be separated experimentally by means of an (n,γ) correlation. At 0° the spin-orbit effects give the only distortions to the correlation function so these must be studied in detail. It is found that all such effects may be lumped into a single parameter. It is also found that the effects are not small in an l = 2 reaction as was found in l = 1 reactions. Finally it is shown that an assumption of pure direct interaction allows one to extract the multipole mixing parameter even in the presence of strong distortions. (auth)

5175 NUCLEAR DIRECT INTERACTION IN THE C^{12}(t,α)B^{11} REACTION. T. Honda, H. Horie, Y. Kudo, and H. Ui (Tohoku Univ., Sendai). Nucl. Phys., 62: 561-74 (Feb. 1965).

By taking into account in detail the cluster structure of ^{12}C and ^{11}B, the angular distributions of α particles leading to the ground and first three excited states of ^{11}B from the ^{12}C(t,α)^{11}B reaction at E_t = 10.06 Mev are treated by the direct-interaction, i.e., the heavy-particle-stripping, pick-up, and knock-on reactions. Expressions for the differential cross sections which were derived previously by the cut-off Born approximation are adopted. The spectroscopic factors contained in all the relevant reduced widths are calculated by employing the harmonic oscillator shell model in the L–S coupling scheme, viz. the α particle and proton reduced widths for the ground state of ^{12}C and the triton reduced widths for the first four low-lying levels of ^{11}B. It is pointed out that three states in ^{8}Be, viz. $p^4[4]^{11}S$, ^{11}D, and ^{11}G are equally important in the wave function of the ground state of ^{12}C when decomposed into the ^{8}Be-α cluster representation and that these states contribute coherently to the heavy-particle-stripping reaction as the core. It is shown that the angular distributions at large angles can be well reproduced by the theory of the heavy-particle-stripping reaction, provided the nuclear cluster structure is correctly taken into account. Further, the angular distributions at small angles are found to be well explained by the pick-up and knock-on reactions. (auth)

5176 STUDY OF THE REACTION ^{27}Al(^{3}He,p)^{29}Si AT 5 Mev. S. Gorodetzky, G. Bassompierre, and A. Gallmann

(Institut de Recherches Nucléaires, Strasbourg). Nucl. Phys., 62: 575-83(Feb. 1965). (In French)

Angular distributions and absolute differential cross section measurements of protons from the $^{27}Al(^3He,p)^{29}Si$ reaction were determined for the first seven states of ^{29}Si. A double stripping mechanism was compared to the angular distributions of the 3.62, 3.07, 2.03-Mev and ground state levels. The theoretical curves in which the coulomb field of the initial nucleus is considered are in fair agreement with the experimental results. (auth)

5177 EXCITATION OF ISOMERIC STATES IN Rh^{103} AND In^{115} BY ELECTRONS. P. Kruger, T. M. Crawford, J. Goldemberg, and W. C. Barber (Stanford Univ., Calif.). Nucl. Phys., 62: 584-92(Feb. 1965).

Yields for the production of the 57 m isomeric state of ^{103}Rh and for the 4.5 h state of ^{115}In were measured both for electrons and photons of energies between 7 and 18 Mev. The electrons were produced by the Linear Accelerator, and the irradiations were made with the stacked foil method. The sensitivity of the electron/photon yield ratio to the multipole character of the reaction was used to obtain information on the absorption process of γ rays. The results of ^{103}Rh lie somewhat lower than, but approximately parallel to, the theoretical results expected for electric dipole absorption. This type of result was observed previously where electric dipole absorption is the dominating mechanism. The results for ^{115}In, on the contrary, are more than a factor of two higher than expected for dipole absorption, indicating that quadrupole or higher multipole transitions have a dominating role. In the course of the experiment the reaction $^{103}Rh(\gamma,2p)^{101}Tc$ was observed. The cross section for this reaction is about three orders of magnitude smaller than that for the (γ,γ') reaction. (auth)

5178 SCATTERING OF HIGH-ENERGY ELECTRONS BY P^{31}. P. Kossanyi-Demay, R. M. Lombard, and G. R. Bishop (Faculté des Sciences, Orsay, France). Nucl. Phys. 62: 615-27(Feb. 1965). (In French)

The cross section for elastic scattering and inelastic scattering of electrons by the nucleus ^{31}P was measured. The elastic cross section is fitted well by a phase-shift calculation for a static charge density with parameters c = 3.21 fm and t = 2.45 fm. The inelastic cross sections are analyzed by the expressions derived in first Born approximation and the analysis leads to the measurement of the reduced transition probabilities and lifetime against radiative decay of a number of levels of ^{31}P. (auth)

5179 CALCULATION OF THE REAL PART OF THE OPTICAL POTENTIAL FOR ALPHA-NUCLEUS SCATTERING. Hans W. Wittern (Florida State Univ., Tallahassee). Nucl. Phys., 62: 628-40(Feb. 1965).

Using two-body forces without hard core for the two-nucleon interactions, the real part of the optical potential for alpha particles scattered on heavy nuclei is calculated. Supposed to apply to nuclei in the mass number range of $16 \lesssim A \lesssim 100$ and to bombarding energies up to about 30 Mev, the result shows that the potential strength increases slowly with the bombarding energy, an effect ascribed to the exclusion principle. The absolute value of the real part is found to be about 130 Mev. (auth)

5180 SPINS OF SLOW NEUTRON RESONANCES IN Hf, Tm, AND Dy. H. Ceulemans and F. Poortmans (S.C.K.-C.E.N., Mol-Donk, Belg.). Nucl. Phys., 62: 641-52(Feb. 1965).

A neutron crystal spectrometer was used for resonance scattering experiments in order to measure the ratio Γ_n/Γ of neutron resonances in the ev region. From these data a value of the resonance spin J is calculated. The following results were obtained: ^{177}Hf (1.1 ev) J = 3; ^{177}Hf (2.4 ev) J = 4; ^{169}Tm (3.92 ev) J = 1; and ^{163}Dy (1.71 ev) J = 2. (auth)

5181 THE ISOBARIC TRIPLET A = 6 AND THE CHARGE-INDEPENDENCE OF NUCLEAR FORCES. Lionel Lovitch (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nucl. Phys., 62: 653-66(Feb. 1965).

The results of calculations in the framework of the shell model are presented which indicate that the direct electromagnetic forces do not explain the energy differences of the A = 6 isobaric triplet. As in the A = 14 triplet, the gap can be bridged by the inclusion of a small charge-dependence of the nuclear forces. (auth)

5182 THE (n,γf) PROCESS. V. Stavinsky and M. O. Shaker (Atomic Energy Establishment, Cairo). Nucl. Phys., 62: 667-72(Feb. 1965).

It is shown that the slow neutron fission of heavy nuclei can occur with an appreciable probability after preliminary emission of a γ quantum. The probability of the (n,γf) process in ^{233}U, ^{235}U, and ^{239}Pu fission by slow neutrons is comparable to the probability of the neutron radiative capture, if the γ radiation is of dipole character. (auth)

5183 PARTIAL EQUILIBRIUM MODEL FOR NUCLEAR REACTIONS. [PART] II. Ko Izumo (Franklin Inst., Swarthmore, Penna. and Tokyo Univ.). Nucl. Phys., 62: 673-89(Feb. 1965).

The gross resonances investigated experimentally at medium excitation energies are analyzed by using the concept that only a small fraction of the nucleons are excited in the compound nucleus. Differential cross sections near resonance are determined by this intermediate resonance theory. The reaction amplitude contains both intermediate resonance and direct interaction terms. In order to calculate statistical quantities the excited nucleons are treated as a Fermi gas, together with a rough estimate of the effect of nucleon-nucleon interactions. Level spacings, nuclear temperatures, and angular distributions are calculated and are compared with experimental results. It is pointed out that nuclear reactions and excited nuclei at medium excitation can be classified into a few groups characterized by the number of excited nucleons. The Lane-Thomas-Wigner theory is applied to intermediate resonances, and the strength function of this model shows that these resonances should appear not only in excitation curves but also in energy spectra of the reactions. (auth)

5184 THE PRODUCTION OF HEAVY HYPERFRAGMENTS BY K^--MESON CAPTURES AT REST IN EMULSION NUCLEI. J. Lemonne (Université Libre, Brussels), C. Mayeur, J. Sacton, D. H. Davis, D. A. Garbutt, and J. Allen. Nuovo Cimento (10), 34: 529-41(Nov. 1, 1964).

In this study of hyperfragment production by K^--meson absorptions at rest in emulsion nuclei, an attempt has been made to estimate the contribution of heavy spallation hyperfragments to the total observed number. In a sample of 24,640 K^- meson captures, 1,612 secondary events have been attributed to the production and subsequent decay of hyperfragments. From a study of the characteristics of both the production and decay disintegrations, it is concluded that about one half of the observed hyperfragments consists of Λ^0 hyperons trapped in the heavy spallation products of silver and bromine and these are almost entirely confined to the (0 to 3) μm range interval. The consequences of their presence are discussed. (auth)

5185 ELASTIC AND INELASTIC SCATTERING OF PROTONS BY ^7Li IN THE ENERGY INTERVAL (3.0 + 5.5) Mev. U. Fasoli, D. Toniolo, and G. Zago (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 34: 542-51 (Nov. 1, 1964).

The cross section and angular distribution of the reactions $^7Li(p,p)^7Li$ and $^7Li(p,p')^7Li^*$ have been measured in the energy interval between 3.0 and 5.5 Mev. The elastic scattering cross section presents a resonance at about 4.2 Mev attributed to a ^8Be state at the excitation energy of 20.9 Mev. (auth)

5186 THE CHARGE-EXCHANGE CONTRIBUTIONS TO π^+ EMISSION IN HYPERNUCLEAR DECAY. R. H. Dalitz (Oxford Univ.) and F. von Hippel. Nuovo Cimento (10), 34: 799-806(Nov. 1, 1964).

The simplest mechanism for production of positive pions in hypernuclei, viz. the $\Lambda \rightarrow n + \pi^0$ decay of the bound Λ particle followed by the pion charge exchange reaction π^0 + (residual nucleus) $\rightarrow \pi^+$ + (nucleons), is studied in order to

estimate the rate constant for positive pion production in hypernuclear decay. The hypernuclei considered include $^{3}H_{\Lambda}$, $^{4}H_{\Lambda}$, $^{4}He_{\Lambda}$, $^{5}He_{\Lambda}$, and $^{7}Be_{\Lambda}$. (T.F.H.)

5187 Fe^{57} MÖSSBAUER EFFECT IN ULTRA FINE PARTICLES OF α-Fe_2O_3. T. Nakamura, T. Shinjo, Y. Endoh, N. Yamamoto, M. Shiga, and Y. Nakamura (Kyoto Univ.). Phys. Letters, 12: 178-9(Oct. 1, 1964).

The Mössbauer effect is used to study the magnetic and spin-relaxation properties of ultrafine particles of Fe_2O_3 at 120 to 300°K. The particle sizes are on the order of 50 Å. (T.F.H.)

5188 ON THE RELATIVISTIC OUTGOING COULOMB WAVE FUNCTION. V. G. Gorshkov (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Letters, 12: 199-200(Oct. 1, 1964).

An expansion of the relativistic Coulomb function in powers of $(\alpha Z)^2 q\ \ln E/E$, where q and E are the momentum transferred to nuclei and the energy of the particle. Each term of this expansion remains meaningful for arbitrary asymptotic momentum p, including $p \to 0$. (T.F.H.)

5189 STATISTICAL FLUCTUATIONS OF THE REACTION $Al^{27}(p,\gamma)Si^{28}$. F. Rauch and E. Roessle (Johann-Wolfgang-Goethe-Universität, Frankfurt am Main). Phys. Letters, 12: 217-18(Oct. 1, 1964).

The excitation functions and autocorrelation functions for $^{27}Al(p,\gamma)^{28}Si$ are determined for proton energies of about 4.5 to 7 Mev. Resonances and fluctuations are discussed. (T.F.H.)

5190 ROTATIONAL BANDS IN O^{16}. J. Borysowicz and R. K. Sheline (Universitet, Copenhagen). Phys. Letters, 12: 219-21(Oct. 1, 1964).

The empirical bands observed in the spectrum of ^{16}O are analyzed, in terms of the theoretical configurations and structures to be expected, using a method based on the SU(3) symmetry group. (T.F.H.)

5191 K-CAPTURE EFFECTS OF ANGULAR CORRELATIONS IN GASEOUS SOURCES. H. J. Leisi (Franklin Inst., Swarthmore, Penna.). Phys. Letters, 12: 221-3 (Oct. 1, 1964).

The perturbing effects of hyperfine interactions on gamma–gamma angular correlations in monatomic gases are studied. The used of these perturbations as means for studying nuclear moments of excited states are outlined. The cases of the 172–203 kev cascade following K-capture in ^{127}I in Xe, and the 55–188 kev cascade following K-capture in ^{125}I in Xe, are discussed as examples. (T.F.H.)

5192 IDENTIFICATION OF A 3^+ STATE IN Ni^{60} WITH THREE PHONON CHARACTERISTICS. D. M. Van Patter and R. K. Mohindra (Franklin Inst., Swarthmore, Penna.). Phys. Letters, 12: 223-5(Oct. 1, 1964).

Proton inelastic scattering by ^{60}Ni at 5.9 Mev produces a gamma ray at 0.47 ± 0.01 Mev, which is identified as a transition between levels at 2.63 and 2.16 Mev. The angular distribution of the 0.47-Mev ray requires a large A_4 coefficient in the Legendre-polynomial description of the distribution. The level at 2.63 Mev is induced on the basis of the character of A_4 to be a 3^+ three-phonon level. (T.F.H.)

5193 STUDY OF THE REACTION MECHANISM IN $Mg^{26}(p,p)$ BY AN ANALYSIS OF CROSS SECTION FLUCTUATIONS. O. Haeusser, P. Von Brentano, and T. Mayer-Kuckuk (Max-Planck-Institut für Kernphysik, Heidelberg). Phys. Letters, 12: 226-8(Oct. 1, 1964).

The contributions of direct and compound-nucleus processes in the inelastic and elastic scattering of protons by ^{26}Mg are found by analysis of the statistical fluctuations of the excitation functions, at proton energies of 8.3 to 14 Mev and angles of 98 to 170°. (T.F.H.)

5194 ENERGY LEVELS IN K^{37} AND Ar^{37}, AND BETA DECAY OF K^{37}. R. W. Kavanagh and D. R. Goosman (California Inst. of Tech., Pasadena). Phys. Letters, 12: 229-33(Oct. 1, 1964).

Data are presented on the energy levels and gamma transitions of ^{37}Ca, $^{36}Ar + p$, ^{37}K, ^{37}Ar, ^{37}Cl, $^{33}K + d - \alpha$, and $^{36}Ar + d - p$. The positron-emission decay scheme of ^{37}K and the electron-capture decay scheme of ^{37}Ar are included. (T.F.H.)

5195 EXCITED STATES OF He^6. N. Gangas (N.R.C. Democritus, Athens), S. Kosionides, R. Rigopoulos, and M. S. Ahmad. Phys. Letters, 12: 233-4(Oct. 1, 1964).

Energy levels of ^6He produced in the reaction $^9Be(n,\alpha)^6He$ are found at 1.66, 3.29, and 6.05 Mev, within 4 to 16%. (T.F.H.)

5196 T = 2 STATES IN THE $T_z = 0$ NUCLEI $O^{16}-Ne^{20}$ AND THE $T_z = 1$ NUCLEI $N^{16}-F^{20}$. J. Cerny (Univ. of California, Berkeley), R. H. Pehl, and G. T. Garvey. Phys. Letters, 12: 234-7(Oct. 1, 1964).

Energy levels having T = 2 are detected in the residual nuclei from (p,^{3}He) and (p,t) reactions with ^{16}O and ^{22}Ne. The T_z values for these residual nuclei are all 0 or 1. (T.F.H.)

5197 HALF-LIFE MEASUREMENTS OF EXCITED STATES IN Tb^{161}, Yb^{177} AND Hf^{179}. K. E. G. Loebner and S. A. De Wit (Instituut vook Kernphysisch Onderzoek, Amsterdam). Phys. Letters, 12: 238-40(Oct. 1, 1964).

The half lives of several excited states in ^{177}Yb and ^{179}Hf are given. The decay scheme of ^{161}Gd to ^{161}Tb, and the half lives of ^{161}Tb states from these decays, are also presented. (T.F.H.)

5198 LEVEL SPACING DISTRIBUTIONS FOR TWO MERGED INDEPENDENT LEVEL SEQUENCES. J. B. Garg (Columbia Univ., New York). Phys. Letters, 12: 240-2(Oct. 1, 1964).

The neutron-resonance-energy data for ^{238}U and ^{232}Th are used to make a comparison between the experimental results and theoretical predictions concerning energy-level repulsion effects in mixtures of these isotopes. The levels of ^{233}Th and ^{239}U observed at neutron energies below 2 kev are merged in order of increasing energy, and the level spacing is then analyzed for 206 levels. (T.F.H.)

5199 STUDIES OF NUCLEAR STATES AT THE FISSION SADDLE-POINT BY INELASTIC ALPHA PARTICLE SCATTERING. B. D. Wilkins, J. P. Unik, and J. R. Huizenga (Argonne National Lab., Ill.). Phys. Letters, 12: 243-5(Oct. 1, 1964).

The distributions of alpha particles and fission fragments from reactions $^{238}U(\alpha,\alpha' f)$ at alpha energy of 43 Mev are measured, in order to analyze the properties of nuclear saddle states of ^{238}U. (T.F.H.)

5200 ON A THEORY OF HIGH-ENERGY PROCESSES BASED ON THE HYPOTHESES OF INDEPENDENT EMISSION AND GAUGE-INVARIANCE. P. Dennery (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France) and A. Krzywicki. Phys. Letters, 12: 265-7(Oct. 1, 1964).

It is shown that the existence of vector bosons coupled to conserved currents necessarily leads to the exponential damping of the transverse momenta of those secondaries that are involved in conserved currents, provided the dominant mechanism of multiple production obeys the rule of independent emission. The argument is based on two assumptions: the existence of vector bosons having certain properties; and factorizability of the collision amplitude for the production of n secondaries. (T.F.H.)

5201 TRANSVERSE MUON POLARIZATION IN NEUTRINO INDUCED INTERACTIONS AS A TEST FOR TIME REVERSAL VIOLATION. S. M. Berman (Stanford Linear Accelerator Center, Calif. and CERN, Geneva) and M. Veltman. Phys. Letters, 12: 275-8(Oct. 1, 1964).

The transverse polarization of muons from reactions of the types ν + nucleus $\to \mu^-$ + (all final states) and the elastic process $\nu + n \to \mu^- + p$ is analyzed at incident ν energies of 0.5 to 2 Bev. It is found that the polarization can be considerable over wide ranges of energy and angle; this result indicates violation of time-reversal invariance in these processes. (T.F.H.)

5202 MÖSSBAUER EFFECT IN I^{127}. F. de S. Barros, N. Ivantchev, S. Jha, and K. Rama Reddy (Carnegie Inst. of

Tech., Pittsburgh). Phys. Letters, 13: 142-4(Nov. 15, 1964).

The Mössbauer spectrum of the 59-kev gamma ray of ^{127}I was obtained using a Te–Zn source and a sodium paraperiodate absorber, both at liquid hydrogen temperature. Several other iodine compounds were tried as absorber. The lower limit of the mean life of the 59-kev level was calculated from the width of the Mössbauer line and was compared with electronically measured values. (D.C.W.)

5203 CHARGE SYMMETRIC PAIRING CORRELATIONS IN LIGHT NUCLEI. J. M. Irvine (Univ. of Manchester, Eng.). Phys. Letters, 13: 144-5(Nov. 15, 1964).

It is shown that the Vogel transformation for treating charge symmetric pairing correlations reduces to the linear quasi-particle transformation of Flowers and Vujicic after an initial transformation of single-particle states. The quasi-particle energies in alpha-particle nuclei are briefly discussed. (D.C.W.)

5204 NUCLEAR MATRIX ELEMENTS FOR THE MIRROR DECAYS OF B^{12} AND N^{12}. J. Eichler, T. A. Tombrello, and J. N. Bahcall (California Inst. of Tech., Pasadena). Phys. Letters, 13: 146-8(Nov. 15, 1964).

It is shown that Coulomb effects alone, as manifested in single-particle binding energies, are large enough to account for the difference in experimental ft-values for the beta decay of ^{12}B and ^{12}N. (D.C.W.)

5205 DELAYED PROTONS FOLLOWING THE DECAY OF S^{29}. J. C. Hardy and R. I. Verrall (McGill Univ., Montreal). Phys. Letters, 13: 148-50(Nov. 15, 1964).

The spectrum of delayed protons following proton bombardment of sulfur was measured. A half life of 195 ± 8 msec was adopted for ^{29}S; and a decay scheme was proposed for ^{29}S, including a previously unreported $T = 3/2$ level at 8.36 Mev. The beta disintegration energy for ^{29}S was estimated to be 14.0 ± 0.2 Mev. (D.C.W.)

5206 THE EXCITATION OF THE ½-LEVEL AT 1.28 Mev IN Cr^{53} BY THE $Cr^{52}(d,p)Cr^{53}$ REACTION. R. Bock, H. H. Duhm, R. Ruedel, and R. Stock (Max-Planck-Institut für Kernphysik, Heidelberg). Phys. Letters, 13: 151-2 (Nov. 15, 1964).

The angular distributions for the $^{52}Cr(d,p)^{53}Cr$ reaction at 10 Mev were measured. The angular distribution for excitation of the 1.28-Mev level could not be fitted by normal DWBA calculations, but required a superposition of stripping curves for two values of the angular momentum of the transferred neutron. Evidence for a contribution of inelastic excitation to the stripping reaction was observed. A two-step process with either inelastic deuteron scattering in the entrance channel or proton inelastic scattering in the exit channel was considered. (D.C.W.)

5207 STATISTICAL ANALYSIS OF FISSION WIDTHS AND FISSION CROSS SECTION IN $U^{235}(n,f)$ REACTION. E. Erba, U. Facchini, E. Saetta-Menichella, and F. Tonolini (Laboratori CISE, Milan and Università, Milan). Phys. Letters, 13: 153-5(Nov. 15, 1964).

The fission widths and cross sections, including the steep rise at the threshold and the large plateau at neutron energies of 4 to 6 Mev, were explained by a statistical model, together with the spontaneous fission of ^{236}U. (D.C.W.)

5208 TREATMENT OF NEUTRON-PROTON CORRELATIONS. M. K. Pal and M. K. Banerjee (Saha Inst. of Nuclear Physics, Calcutta). Phys. Letters, 13: 155-7 (Nov. 15, 1964).

A ground-state wave function containing four-particle groups (quadrupoles) in addition to the usual pairs was previously obtained by Vogel for N = Z nuclei in a linear quasi-particle theory. The ground state wave function is obtained in a more general form, and it is shown that the quadrupoles in the ground state in the linear theory are not genuine. (D.C.W.)

5209 THE ROLE OF SURFACE VIBRATIONS IN FORMING THE GIANT DIPOLE RESONANCE OF SPHEROIDAL NUCLEI. S. F. Semenko (Lebedev Inst. of Physics, Moscow). Phys. Letters, 13: 157-9(Nov. 15, 1964).

The effect of surface vibrations on the properties of the dipole resonance in strongly deformed axially symmetric nuclei is investigated. The coupling of dipole and γ-vibrations is considered. (D.C.W.)

5210 ON CORIOLIS FORCES AND PAIR CORRELATIONS CONTRIBUTIONS TO ALAGA'S RULES VIOLATION. E. E. Berlovich (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Letters, 13: 161-3(Nov. 15, 1964).

The ratio of the reduced probabilities of E1 transitions from the single-particle level to the ground, first, and second rotational levels of the ground-state bands of ^{177}Hf and ^{173}Yb was calculated, accounting for Coriolis mixtures to the initial and final states as well as mixtures of states lying above and below the Fermi surface. Calculations were made for Coriolis mixing alone and for Coriolis mixing with pairing corrections. The results were compared with experimental observations and the predictions of Alaga's rules. (D.C.W.)

5211 CONNECTION BETWEEN THE AMPLITUDES OF THE REACTIONS (d,d'), (d,N), (N,d) AND (N,N') IN THE NON-RELATIVISTIC CASE. V. V. Komarov (Australian National Univ., [Canberra]). Phys. Letters, 13: 163-5 (Nov. 15, 1964).

The relation between the amplitudes for the four processes is obtained. Integral equations are given for the amplitudes. (D.C.W.)

5212 QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE IN I^{127} BY THE MÖSSBAUER EFFECT. G. J. Perlow and S. L. Ruby (Argonne National Lab., Ill.). Phys. Letters, 13: 198-200(Dec. 1, 1964).

Mössbauer measurements on iodine-127 at 77°K where the absorption for a single line is typically 0.5% and at 4°K where it is an order of magnitude larger are reported. The source is $Zn^{127}Te$. The isomer shift, the magnitude and sign of the quadrupole coupling, and the ratio of the quadrupole moment of the excited state to that of the ground state are determined. (C.E.S.)

5213 THE SPIN AND MOMENTS OF Hg^{193}. H. Kleiman, S. P. Davis, and Tin Aung (Univ. of California, Berkeley). Phys. Letters, 13: 212-13(Dec. 1, 1964).

The direct measurement of a nuclear spin of $I = 3/2$ for ^{193}Hg by the techniques of high resolution spectroscopy is reported. The magnetic moment was determined to be $-0.607 \pm 0.02\ \mu_B$. (C.E.S.)

5214 CLASSICAL PROTON–HYDROGEN SCATTERING CROSS-SECTIONS. R. Abrines and I. C. Percival (Kingston Coll. of Tech., London and Queen Mary Coll., London). Phys. Letters, 13: 216-17(Dec. 1, 1964).

The classical ionization and charge-transfer cross sections for collisions of protons with ground-level H atoms were obtained. Newton's equations for the three-body motion of the 2 protons and 1 electron were solved by numerical integration for a large number of orbits. (C.E.S.)

5215 GAMMA-RAY SPECTROSCOPY ON 155-DAY Lu^{177} USING LITHIUM-DRIFTED GERMANIUM COUNTERS. J. Blok and D. A. Shirley (Univ. of California, Berkeley). Phys. Letters, 13: 232-4(Dec. 1, 1964). (UCRL-11644)

Lithium drifted germanium gamma detectors were used to study the spectrum from the decay of the isomer of ^{177}Lu. The presence of the 426-kev gamma ray was detected, thus establishing the $^{13}/_{2}$ member of the $^{7}/_{2}^{-}$ [514] band. (C.E.S.)

5216 NUCLEAR SPECTROSCOPY WITH (d,p) AND (d,t) REACTIONS ON Tl^{205}. P. Mukherjee (Saha Inst. of Nuclear Physics, Calcutta and Univ. of Pittsburgh). Phys. Letters, 13: 238-40(Dec. 1, 1964).

The experimental (d,p) and (d,t) spectra with a 99% enriched ^{205}Tl target are analyzed. For comparison the $^{206}Pb(d,p)$, $^{206}Pb(d,t)$, and the $^{203}Tl(d,p)$ spectra are included. The incident deuteron energy in all these reactions was 15 Mev. (C.E.S.)

5217 ON THE THOMAS-REICHE-KUHN SUM RULE. S. B. Gerasimov (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 13: 240-2(Dec. 1, 1964).

An attempt is made to derive the Thomas-Reiche-Kuhn sum rule for the nuclear photoeffect in the framework on nonrelativistic theory. It is shown that the precise cancellation of the contribution of all higher multipoles and the effect of the retardation of the dipole absorption takes place in the sum rule. The γ-ray interaction with an arbitrary nonrelativistic system is considered. (C.E.S.)

5218 INDICATION OF A Y_{40}-DEFORMATION IN HEAVY NUCLEI. M. G. Huber (Universität, Freiburg i. B.). Phys. Letters, 13: 242-3(Dec. 1, 1964).

Data from the alpha decay of deformed even nuclei are discussed, and it is shown that the discrepancies between experimental and theoretical results seem to indicate a Y_{40} deformation in the nuclear shape. (C.E.S.)

5219 COLLECTIVE MULTIPOLAR EXCITATIONS OBSERVED BY THE INELASTIC SCATTERING OF α PARTICLES IN THE EVEN ISOTOPES OF TIN—COMPARISON WITH THOSE OF NICKEL. G. Bruge, J. C. Faivre, H. Faraggi, J. Saudinos, and G. Vallois (Centre d'Etudes Nucléaires, Saclay, France). Phys. Letters, 13: 244-6 (Dec. 1, 1964). (In French)

Inelastic scattering of 44-Mev α particles by the even isotopes of tin—116, 118, 120, 122, and 124—was studied. Effective differential cross sections between 35 and 90° cms were obtained for the most intense groups. Results were analyzed using the diffraction model and the universal curves of Blair. Calculated maxima of the angular distributions and observed maxima in the effective differential reduced cross sections are presented in the universal representation for the 2^+ and 3^- levels of the tin isotopes; these are compared with previously observed cross sections for even nickel isotopes. Collective multipolar excitations for Z = 50 are not found to be very different from those for Z = 28. Only the quadrupole excitation is noticeably weaker. The presence of a second group of octupolar excitation toward 5 Mev was observed. (M.J.T.)

5220 ON THE NATURE OF DEFORMATION IN EVEN-EVEN NUCLEI BETWEEN A = 180 AND 192. M. R. Gunye (Atomic Energy of Canada Ltd., Chalk River, Ont.), S. Das Gupta, and M. A. Preston. Phys. Letters, 13: 246-8(Dec. 1, 1964).

An attempt is made to answer the questions of whether the nuclei in the transition region are really asymmetric and do they possess stable equilibria or are they soft towards vibrations, in particular, γ-vibrations. A model that uses empirical single-particle level shifts and makes the assumption of nuclear incompressibility is discussed. (C.E.S.)

5221 THE DETERMINATION OF PARTIAL NUCLEAR MULTIPOLE MOMENTS BY DIRECT REACTION SUM RULES. J. B. French (Univ. of Rochester, N. Y.). Phys. Letters, 13: 249-52(Dec. 1, 1964).

The direct reaction sum rules for determining partial nuclear multipole moments are derived, and the way in which they are applied is discussed. (C.E.S.)

5222 NUCLEAR CAPTURE OF K^- MESON AT REST. G. T. Condo (Univ. of Tennessee, Knoxville) and R. D. Hill. Phys. Letters, 13: 271-2(Dec. 1, 1964).

Recent experiments on the absorption of mesons (K^-) at rest indicate that those events leading to the emission of $\Sigma\pi$ pairs are more frequent in the light nuclei (C, N, O) than in the heavy nuclei (Ag,Br) of nuclear emulsion. An attempt is made to demonstrate that these observations are inconsistent with the rather wide-spread impression that mesons (K^-) are captured in heavy nuclei by an exclusively peripheral process. (C.E.S.)

5223 $(p\mu p)^+$ MOLECULE; MUON CAPTURE IN HYDROGEN. A. Halpern (Columbia Univ., New York). Phys. Rev. Letters, 13: 660-2(Nov. 30, 1964).

The bound-state (pμp) ortho, L = 1, odd-parity wave function was calculated using a variational method taking into full account the motion of the protons. The results are used to evaluate the meson (μ) capture rate in hydrogen. (C.E.S.)

5224 LARGE-SPIN ROTATIONAL STATES OF DEFORMED NUCLEI. Samuel M. Harris (Columbia Univ., New York and Purdue Univ., Lafayette, Ind.). Phys. Rev. Letters, 13: 663-5(Nov. 30, 1964).

An explanation is presented for the increase of moment of inertia with higher angular-momentum states for a given nucleus. The next higher order term in the usual cranking-model result for the moment of inertia is used as the basis for this explanation. Results are tabulated for a few representative nuclei. (C.E.S.)

5225 NEW ISOTOPE OF NITROGEN: N^{18}. L. F. Chase, Jr., H. A. Grench, R. E. McDonald, and F. J. Vaughn (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev. Letters, 13: 665-8(Nov. 30, 1964).

Evidence for the production of nitrogen-18 in the reaction $^{18}O(n,p)^{18}N$ was obtained. The half life of ^{18}N was measured, and information about its decay scheme was also determined. (C.E.S.)

5226 REACTION $\Sigma^- + {}^4He \rightarrow \Lambda^0 + n + {}^3H$. H. O. Cohn and K. H. Bhatt (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 13: 668-70(Nov. 30, 1964). (ORNL-P-569)

When hyperons (Σ^-) are absorbed at rest in helium the only possible final state, apart from hyperfragment production, is $\Sigma^- + {}^4He \rightarrow \Lambda^0$ + nucleons, Σ^0 production being forbidden by energy considerations. Such events were examined by exposing a helium bubble chamber to a stopping beam of mesons (K^-). Events kinetically fitted to the hypothesis $\Sigma^- + {}^4He \rightarrow \Lambda^0 + n + {}^3H$ were analyzed. The hyperon (Λ), neutron, and triton momentum spectra and the effective-mass distribution in the Λ-n system are illustrated. (C.E.S.)

5227 FINAL-STATE INTERACTIONS IN THE REACTION $He^3(d,t)2p$ AT 24.7 AND 33.4 Mev. H. E. Conzett, E. Shield, R. J. Slobodrian, and S. Yamabe (Univ. of California, Berkeley). Phys. Rev. Letters, 13: 625-8(Nov. 23, 1964).

The differential energy spectra of tritons from the $^3He(d,t)2p$ reaction at 24.7 and 33.4 Mev were measured. The spectra were fitted with calculations based on the final-state interaction of the two protons. (D.C.W.)

5228 EVIDENCE FOR A SINGLE DOMINANT STATE FOR THE E1 GIANT RESONANCE. R. G. Allas, S. S. Hanna, L. Meyer-Schuetzmeister, R. E. Segel, P. P. Singh, and Z. Vager (Argonne National Lab., Ill.). Phys. Rev. Letters, 13: 628-31(Nov. 23, 1964).

Experimental observations on the (p,γ) giant resonance (particularly in ^{12}C, ^{20}Ne, and ^{28}Si) are discussed, together with the predictions of the particle-hole model. Evidence is noted indicating that the giant resonance can be interpreted in terms of a single configuration spread over many actual nuclear levels rather than by separated particle-hole states. (D.C.W.)

5229 AN ANALYSIS OF THE LOW ENERGY NEUTRONS FROM $^7Li + {}^2H$. J. P. Sah (Lucknow Univ., India). Physica, 30: 1713-16(Sept. 1964).

It was found that between 30 and 50% of the observed disintegrations take place by way of formation of ^5He in the intermediate stage, which subsequently breaks up emitting a neutron. The mode of the $^7Li + {}^2H$ reaction through ^5He formation seems more probable at higher excitation energies. (auth)

5230 CROSS SECTIONS OF SOME (n,p) AND (n,2n) REACTIONS. I. Heertje, L. Delvenne, W. Nagel, and A. H. W. Aten, Jr. (Institutt voor Kernphysich Onderzoek, Amsterdam). Physica, 30: 1762-70(Sept. 1964).

With neutrons produced by bombarding thick targets of Be, Co, and Ta with 26-Mev deuterons in the external beam of the Amsterdam cyclotron, a number of (n,p) and (n,2n) cross sections was investigated. The following reactions were studied: $^{58}Ni(n,p)^{58}Co$, $^{24}Mg(n,p)^{24}Na$, $^{14}N(n,2n)^{13}N$, $^{16}O(n,2n)^{15}O$, $^{19}F(n,2n)^{18}F$, $^{23}Na(n,2n)^{22}Na$, $^{58}Ni(n,2n)^{57}Ni$, $^{127}I(n,2n)^{126}I$, $^{204}Pb(n,2n)^{203}Pb$. (auth)

5231 THE ENERGY LEVELS IN ^{94}Mo POPULATED BY THE DECAYS OF ^{94}Tc AND ^{94}Tc^{m}. J. H. Hamilton, K. E. G. Loebner, A. R. Sattler, and R. Van Lieshout (Institutt Voor Kernphysich Onderzoek, Amsterdam). Physica, 30: 1802-12(Sept. 1964).

The decays of the 52 min and 293 min isomers of ^{94}Tc were studied with scintillation spectrometers and with an iron-free, double-focusing beta spectrometer. The maximum energies of the positron spectra in the 52 min and the 293 min decays were measured in the iron-free spectrometer to be 2474 ± 36 and 816 ± 5 kev respectively. The 52 min activity was established as ^{94m}Tc and is 107 ± 37 kev above the 293 min activity which is ^{94}Tc. No indication was found for direct transitions between the two activities. The energies of the triple gamma cascade in the ^{94}Tc decay were determined to be 849.4 ± 0.7, 702.2 ± 0.7, and 870.7 ± 0.7 kev from measurements of the K conversion electrons. The intensities of these three transitions are equal within better than 10%. Two previously unreported gamma ray transitions were observed in the ^{94}Tc decay at 434 ± 1 and 1600 ± 100 kev of which the first is an M1 or E2 transition. It was shown that these two transitions populate the level at 2422 kev. In the 52 min ^{94m}Tc decay, the existence of a 1530 and two 2410 kev gamma rays was confirmed, in addition to the other known transitions. A modified decay scheme is proposed. (auth)

5232 APPLICATION OF THE EXTENDED SIEGERT THEOREM TO MUON CAPTURE REACTIONS. Akihiko Fujii (Tokyo Univ.), Jun-Ichi Fujita, and Masato Morita. Progr. Theoret. Phys. (Kyoto), 32: 438-49(Sept. 1964).

On the basis of the conserved vector current theory the extended Siegert theorem is given and applied to the muon capture reactions. As a consequence a relation among the nuclear matrix elements is found in each forbiddenness. (auth)

5233 ABSOLUTE MEASUREMENT OF RADIOACTIVITY BY USE OF THE $4\pi\beta-\gamma$ COINCIDENCES METHOD. A. Filip, I. Girlea, V. Papureanu, and G. Fodor (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 357-64(1964).

A method is presented for checking the intrinsic accuracy of the $4\pi\beta-\gamma$ coincidence method for absolute determination of disintegration rates. (D.C.W.)

5234 ERRORS IN DETERMINING THE EXPONENTIAL CONSTANTS OF THE COMPONENTS IN A RADIOACTIVE MIXTURE. A. Filip (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 393-9(1964).

The error arising in the determination of individual half lives or exponential absorption coefficients by graphical analysis of the total curve for the mixture is calculated. Both systematic and random measurement errors are considered. (D.C.W.)

5235 ELASTIC REFLECTION OF ELECTRONS FROM TUNGSTEN IN THE ENERGY RANGE FROM 100 TO 2000 ev. Yu. A. Morozov and A. R. Shul'man (Kalinin Polytechnical Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 726-7(Sept. 1964). Translated from Fiz. Tverd. Tela, 6: 943-5(Mar. 1964).

The elastic reflection of electrons from tungsten was investigated in the energy range 100–2000 ev. The energy dependence of the coefficients of secondary electron emission and inelastic and elastic reflection is illustrated. (C.E.S.)

5236 EXCITATION OF A SINGLE-PHONON QUADRUPLET IN THE CASE OF THE INELASTIC SCATTERING OF DEUTERONS ON COPPER ISOTOPES. O. F. Nemets, L. I. Slyusarenko, and V. V. Tokarevskii (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 9: 564-6(May 1964). (In Ukrainian)

A selective scintillation spectrometer was used to record the scattering of a deuteron beam on various Cu isotopes at 13.6 Mev. The angular distributions for the inelastic scattering of deuterons on ^{62}Cu and ^{64}Cu at Q = −1.1 and −1.3 Mev were obtained. The highest peak of inelastic scattering on the Cu isotopes was determined on the basis of the excitation of a single-phonon quadruplet term. The values for the orbital moment of L = 2, obtained from the experimental angular distribution data, were compared with the results of the theoretical calculations of Huby (Phil Mag. 42, 1442(1951)); they were found to agree satisfactorily. (TTT)

5237 POLARIZATION OF 6.9-Mev PROTONS, ELASTICALLY SCATTERED BY NICKEL ISOTOPES. M. V. Pasichnik and V. I. Chirko (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 9: 576-7(May 1964). (In Ukrainian)

The angular distribution and the polarization of 6.9-Mev protons after scattering by ^{58}Ni, ^{60}Ni, ^{62}Ni, and ^{64}Ni nuclei were measured. The double scattering method was used for the determination of the proton polarization; this involved the measurement of the left and right symmetry by means of a scintillation spectrometer with a photomultiplier and a CsI(Tl) crystal placed at 45° with respect to the proton beam. The polarization of the protons after scattering by ^{58}Ni and ^{60}Ni at 110° was found to be considerable; but in the case of ^{62}Ni and ^{64}Ni its value was near zero. (TTT)

5238 DIFFERENTIAL CROSS SECTIONS OF NEUTRONS, ELASTICALLY SCATTERED BY Si, Cr, Zr, Pb AND Bi NUCLEI. I. O. Korzh, M. T. Sklyar, and I. A. Totskii (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 9: 577-8(May 1964). (In Ukrainian)

A methane-filled proportional counter was used to measure the differential cross sections for neutron elastic scattering by Si, Cr, Pb, and Bi at 300 ± 25 kev and by Si and Cr at 800 ± 50 kev. The experiments were carried out with neutrons generated by the T(p,n)^{3}He reaction in an electrostatic generator, using spherical targets of the natural isotopic mixture of the elements as the scatterer. The differential elastic scattering cross section data obtained indicate that the angular distribution is anisotropic. Elements possessing widely differing atomic numbers were also found to have different angular distributions, while neighboring elements, such as Pb and Bi, exhibit great similarities in their angular distributions. (TTT)

5239 EXISTENCE OF AN ISOMERIC STATE OF THE HYPERNUCLEUS $_{\Lambda}$He^{7}. M. Rayet (Université Libre, Brussels). Univ. Bruxelles, Inst. Phys., Bull., No. 15, 11p. (July 1964). (In French)

In order to explain the unusual spread in the B_{Λ} values observed for the hypernucleus $_{\Lambda}$He^{7}, Pniewski and Danysz have suggested the existence of an excited state of $_{\Lambda}$He^{7} with a lifetime greater than the lifetime of the hypernucleus itself. Elton has calculated the lifetime of this state, but without concluding undoubtedly that this lifetime is greater than the lifetime of the hypernucleus so this calculation was made again. It is shown that the binding energy B_{Λ}^{*} for the excited state considered, depends on the nuclear coupling scheme. In the case of j-j coupling, the excited level is split into a J = 3/2 and a J = 5/2 level, these two levels being stable under particle emission. The effect of the hyperon(Λ) on a γ transition in the hypernucleus is discussed. The only effect of importance is a radial compression of the nuclear core. The E_2 transition probability from the excited (2^{+}) to the ground (0^{+}) state of ^{6}He in the presence of the hyperon(Λ) is then calculated. A configuration mixing of harmonic oscillator wave functions is used to describe the ^{6}He nucleus. The configuration mixing coefficients are calculated using a two-body interaction whose parameters are given by low energy n-p scattering data. A lifetime is found for the γ transition $\tau_{\gamma} = 7 \times 10^{-10}$ sec. This lifetime is greater than the mean lifetime of the hyperon(Λ) $\tau_{\Lambda} = 2.5 \times 10^{-10}$ sec, thus allowing the Λ-decay of $_{\Lambda}$He^{7} from its excited state. (auth)

5240 TWO CLOSELY SPACED RESONANCE LEVELS OF $Na^{23}(p,\alpha)$ REACTION. Ming-han Yeh, Guang-chang Shah, Ming Chung, Ying-ping Chang, and Chung-yao Chao. Wu Li Hsueh Pao, 20: 728-30(Aug. 1964). (In Chinese)

The α_0 excitation curve of ^{23}Na(p,α) reaction was measured at proton energies in the neighborhood of 1416 kev. While only one resonance level was known previously in

this region, the presence of two levels was discovered, one at 1416.8 and another at 1410.4 ± 1.0 kev. The decay of this latter level is mainly through emission of an α particle to the ground level of ^{20}Ne. (auth)

5241 MEASUREMENT OF THE K-CONVERSION COEFFICIENTS OF NUCLEAR ISOMERS Pd^{107m} AND Pd^{109m}. Winfried Weirauch (Universität, Göttingen, Ger.). Z. Physik, 181: 273-80(1964). (In German)

The K-conversion coefficients α_K of the isomers ^{107m}Pd and ^{109m}Pd were measured by detecting the K x-rays and gamma rays from neutron-irradiated Pd samples, using a NaI(Tl) scintillation spectrometer. The results are α_K = 0.41 ± 0.02 and α_K = 0.52 ± 0.04, respectively. These values were compared with those taken from the tables of Rose, confirming the assumption of E3 transitions which was previously proposed elsewhere. In addition, the assignment of the 21 sec-activity to ^{107m}Pd was confirmed. (auth)

5242 U^{238} FISSION BY 14-Mev NEUTRONS. Friedrich Goennenwein (Universität, Tübingen, Ger.). Z. Physik, 181: 281-92(1964). (In German)

The energies of the two fission fragments from the ^{238}U(n,f) reaction at 14 Mev were analyzed in coincidence using Si surface detectors. The resultant mass distribution is in fair agreement with radiochemical data. The average kinetic energy release before prompt neutron emission was found to be 160.8 ± 4 Mev. For symmetric fission, a kinetic energy dip was observed. The anisotropy α in the postulated angular distribution $W(\Theta) = 1 + \alpha \cos^2\Theta$ is strongly dependent on mass ratio, being positive and greatest for asymmetric fission. The value of α averaged over all mass ratios, 0.33 ± 0.07, compares well with published data. The results are discussed in terms of new fission models. (auth)

5243 INVESTIGATION OF THE DECAY OF Ag^{110m} BY γγ DIRECTIONAL CORRELATION MEASUREMENTS. F. Muennich, K. Fricke, and J. Koch (Technische Hochschule, Brunswick). Z. Physik, 181: 301-16(1964). (In German)

Directional correlation measurements were made on six different gamma-gamma cascades in ^{110}Cd, following the beta decay of ^{110m}Ag. The observed correlation functions are presented. These results, together with recent experimental results on internal conversion coefficients, permit unique spin and parity assignments to all but one known level of ^{110}Cd. (D.C.W.)

5244 DECAY OF Lu^{176m}. Max Heinzelmann (Universität, Gottingen, Ger.). Z. Physik, 181: 347-55(1964). (In German)

The decay of ^{176m}Lu was investigated. The K-conversion coefficient α_K of the 88.3-kev level of ^{176}Hf was determined to be 1.35 ± 0.07. The β-branching ratio to the 0+ and 2+ levels of ^{176}Hf was measured by means of a β-γ-coincidental technique; 60.4 ± 6.1% of ^{176m}Lu decays into the 2+ level and 39.6 ± 6.1% into the 0+ level of ^{176}Hf. K-capture of ^{176m}Lu to ^{176}Yb was not found. If there is any, it is less than 0.1% of all decays. (auth)

5245 COMPARATIVE MEASUREMENT OF ELECTRON POLARIZATION IN β DECAY: Re^{186} AND P^{32}. Rudolf Loehken, Heinigerd Rebel, and Gerd Schatz (Universität, Heidelberg). Z. Physik, 181: 396-400(1964). (In German)

The ratio of longitudinal polarization values of ^{186}Re and ^{32}P β particles was measured by the method of double scattering. The result obtained is $P(^{186}Re)/P(^{32}P) = 1.002$ at 540 kev. The contributions of the ground-state transition and the first excited transition of ^{186}Re are 78% and 22%, respectively, at this energy for the apparatus used. (auth)

5246 INVESTIGATION OF VANADIUM-52 DECAY. Hans Georg Eckert (Universität, Gottingen, Ger.). Z. Physik, 181: 401-12(1964). (In German)

The gamma rays of the decay of ^{52}V were investigated with NaI crystals and gamma-gamma cascades were sought by a fast-slow coincidence circuit. Three gamma-transitions with energies of 0.935 (0.14%), 1.331 (0.9%), and 1.531 Mev (0.16%), respectively, in coincidence with the 1.434 Mev transition were detected. It is concluded that there are four branches of ^{52}V beta decay: 2.47 Mev (98.8%, log ft = 5.1), 1.53 Mev (0.14%, log ft = 7.0), 1.14 Mev (0.9%, log ft = 5.7), and 0.94 Mev (0.16%, log ft = 6.1). The spin and parity of ^{52}V ground level are concluded to be 3+. (auth)

5247 POLARIZATION OF NEUTRONS IN THE REACTION $D(d,n)He^3$. N. P. Babenko, I. O. Konstantinov, A. P. Moskalev, and Yu. A. Nemilov. Zh. Eksperim. i Teor. Fiz., 47: 767-8(Aug. 1964). (In Russian)

Neutron polarization values for the reaction $D(d,n)^3$He were measured for deuteron energies of 4.7 and 5.6 Mev and a reaction angle of 45° in the cms. The neutrons were analyzed using a high-pressure gas scintillation counter and near 135° cms were registered by lateral plastic scintillators. The measured values of asymmetry and polarization are given and compared with previous experimental values. A discrepancy in previous data on the polarization for deuteron energies above 2 Mev exists; the present results support values giving the higher polarization. (M.J.T.)

5248 RESONANCE SCATTERING OF γ-QUANTA ON NUCLEI Sr^{88}. R. B. Begzhanov and A. A. Islamov (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Zh. Eksperim. i Teor. Fiz., 47: 768-70(Aug. 1964). (In Russian)

The self-absorption method was used to determine the lifetime of the 1.85-Mev excited level of ^{88}Sr. Spectra of scattered radiation from Sr and Cu scatterers are compared; the lifetime calculated from the data is $(1.10 \pm 0.22) \times 10^{-13}$ sec. The result obtained enables the first excited state of the even-even nucleus ^{88}Sr to be interpreted as the result of quadrupole oscillations of the nuclear surface around an equilibrium spherical shape, using the collective model. Calculated values of vibration parameters for ^{88}Sr and ^{96}Mo are also presented. (M.J.T.)

5249 CROSS SECTION FOR RADIATIVE CAPTURE OF NEUTRONS WITH ENERGIES UP TO 50 Kev BY THALLIUM ISOTOPES. V. A. Konks and F. L. Shapiro (Lebedev Inst. of Physics, Moscow and Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 47: 795-800(Sept. 1964). (In Russian)

The dependence of radiative capture cross section on neutron energy is measured for thallium by the slowing down-time technique. Plots of the cross sections and the resonance absorption integrals are presented. The radiative width of the 238-ev level in ^{203}Tl is determined (Γ_γ = 0.64 ± 0.07 ev). The mean distances between the resonances in ^{203}Tl and ^{205}Tl are determined on the basis of the magnitude of the capture cross section. (auth)

5250 ESTIMATION OF THE CHARGE EXCHANGE CROSS SECTION FOR π^- MESONS ON QUASI-FREE PROTONS AT 9 Gev/c. I. M. Gramenitskii, L. S. Okhrimenko, B. Slovinskii, and Z. S. Strugalskii (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 47: 801-5(Sept. 1964). (In Russian)

Charge exchange of mesons(π^-) on protons of Xe nuclei resulting in the formation of π^0 mesons is studied by inspection of photographs obtained in a xenon bubble chamber irradiated with 9-Bev/c mesons(π^-). The magnitude of the cross section thus derived indicates that elastic charge exchange of 9-Bev/c mesons (π) is infinitesimal. (auth)

5251 ELASTIC SCATTERING OF DEUTERONS ON SEPARATED NICKEL AND ZINC ISOTOPES. V. P. Bochin, K. I. Zherebtsova, V. A. Komarov, L. V. Krasnov, V. F. Litvin, and Yu. A. Nemilov (Leningrad State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 855-9(Sept. 1964). (In Russian)

The angular distributions of elastically scattered 6.5-Mev deuterons are measured with a multi-angle magnetic analyzer. An isotopic effect was found which consists in a systematic variation of the angular distributions of deuterons scattered on even-even nuclei with increase of the number of neutrons. The nature of variation of the angular distributions can be explained by the increase of the dif-

fuseness of the surface layer of the nucleus which occurs as the number of neutrons increases. (auth)

5252 ON DETERMINATION OF THE CHANGE OF PARITY IN INELASTIC SCATTERING. E. V. Inopin. Zh. Eksperim. i Teor. Fiz., 47: 892-5(Sept. 1964). (In Russian)

Numerical calculations of inelastic scattering due to the direct interaction mechanism show that the forward direction scattering differential cross sections are respectively very small or very large depending on whether or not the nuclear parity of the scattered nucleus changed. An explanation of this rule is presented within the framework of the adiabatic approximation for scattering processes. (auth)

5253 EFFECT OF THRESHOLD LEVELS ON THE SHAPE OF THE PHOTONEUTRON SPECTRUM. A. I. Baz and V. P. Zommer. Zh. Eksperim. i Teor. Fiz., 47: 1041-2(Sept. 1964). (In Russian)

It is shown that irregularities in the spectra of photoneutrons from magic nuclei can be explained if the contribution of threshold levels are taken into account. (auth)

5254 NUCLEAR PRECESSION OF NEUTRONS. V. G. Baryshevskii and M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1050-4(Sept. 1964). (In Russian)

The passage of slow polarized neutrons through a polarized target is considered from a general viewpoint. It is shown that the neutron spin experiences precession around the direction of polarization of the target with a definite frequency which is independent of the neutron velocity. Phenomena similar to paramagnetic resonance of neutrons at this frequency are discussed. (auth)

5255 QUANTUM THEORY OF SCATTERING OF PARTICLES IN MATTER WITHOUT USE OF THE KINETIC EQUATION. N. P. Kalashnikov and M. I. Ryazanov (Moscow Inst. of Engineering Physics). Zh. Eksperim. i Teor. Fiz., 47: 1055-64(Sept. 1964). (In Russian)

The quantum function for distribution of particles in matter is obtained in terms of the scattering amplitude on a separate scatterer. The method is based on quantum theory, does not make recourse to the kinetic equation, and yields a unified description of multiple scattering through small angles as well as plural scattering through large angles. The quantum distribution function for Coulomb scattering is identical with the classical function in the case of small angles and yields Rutherford scattering at large angles. In the intermediate range it leads to appreciable quantum corrections which were not taken into account in the works of others. (auth)

5256 ON A CERTAIN INTERFERENCE EFFECT IN NUCLEON TRANSFER REACTIONS. V. M. Strutinskii. Zh. Eksperim. i Teor. Fiz., 47: 1065-73(Sept. 1964). (In Russian)

The channels of an inelastic reaction with large orbital momenta correspond to waves passing under the centrifugal barrier. The phases of these waves differ by π from those of the superbarrier waves with smaller l values. This results in a characteristic interference splitting of the edge maximum in the angular distribution into two narrower maxima. Some results of numerical calculations in the edge reaction model are presented. (auth)

5257 THERMAL NEUTRON CAPTURE ON DEUTERONS. B. V. Struminskii (Inst. of Mathematics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1147-9 (Sept. 1964). (In Russian)

Electron scattering experiments on ^{3}H and ^{3}He indicate that the nuclear wave function possesses a mixed symmetry S state. The probability for the mixed symmetry S state is derived from experimental data on capture of slow neutrons on deuterons. (auth)

5258 STUDY OF THE β AND γ RADIATION OF ^{43}Sc AND ^{117}Sb. K. A. Baskova, S. S. Vasil'ev, M. A. Khamo-Leila, and L. Ya. Shavtvalov. Zh. Eksperim. i Teor. Fiz., 47: 1162-4(Sept. 1964). (In Russian)

The β and γ spectra and β-γ coincidences were measured using a magnetic-lens β spectrometer and scintillation γ spectrometer. The γ spectrum, decay scheme, and Fermi graph of the β-γ coincidence spectrum at 370 and 620 kev are given for ^{43}Sc. (M.J.T.)

5259 STUDY OF THE β^+ SPECTRA OF ^{19}Ne, ^{67}Ge, ^{118}Sb, AND OF THE γ EMISSION AFTER α IRRADIATION OF ^{197}Au. S. S. Vasil'ev, E. T. Dzhorzh and L. Ya. Shavtvalov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1164-7(Sept. 1964). (In Russian)

A magnetic-lens β spectrometer was used for the studies. Maximum β^+ energies and half lives are given for ^{19}Ne and ^{67}Ge. The ^{118}Sb Fermi graph, maximum energies of the partial spectra, and half lives for each energy limit are presented. The ^{197}Au conversion spectrum is given for a time lag of 10 msec. Results of all the measurements are compared with those of previous experiments. (M.J.T.)

5260 THE ISOMER ^{115m}Te. D. E. Khulelidze, V. L. Chikhladze, and V. G. Onufriev. Zh. Eksperim. i Teor. Fiz., 47: 1167-8(Sept. 1964). (In Russian)

The ^{112}Sn(α,n)^{115}Te and ^{114}Sn(α,n)^{117}Te reactions at 21 Mev were compared. For the ^{112}Sn target, two lines were observed in the internal conversion spectrum and identified as K and L conversion electrons of the 275-kev γ transition; the lines were not found with the ^{114}Sn target. Thus the existence of a ^{115m}Te isomeric state is shown, with half life 104 ± 5 msec, isomeric transition energy 275 ± 3 kev, and transition type M3. The spin-parity derived from the shell model is $\frac{1}{2}^+$. (M.J.T.)

5261 DECAY OF SOME MILLISECOND ISOMERS. V. V. Remaev, Yu. S. Korda, and A. P. Klyucharev (Inst. of Physics and Tech., Academy of Sciences, Ukranian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1172(Sept. 1964). (In Russian)

Corrected values are given for the total conversion coefficients of isomers of ^{71}Ge, ^{90}Nb, ^{138}Ce, and ^{140}Nd and for the most probable values of the multipole types of the corresponding γ transitions. (M.J.T.)

5262 CAPTURE REACTIONS. (International Atomic Energy Agency, Vienna). 1964. Bibliographical Series No. 12. 140p. (STI/PUB/21/12). $3.00; Sch 63; 18s.std; F.fr.12; DM 10.50 (IAEA).

A total of 697 references is given on the reactions (p,γ), (n,γ), (d,γ), (α,γ), etc. The material covers the period Jan. 1948 to Aug. 1963, and is classified in seven chapters according to reaction and within each reaction according to nuclide. An author index is included. (R.E.U.)

5263 ELECTRICAL DISCHARGE VESSEL FOR THE PRODUCTION OF NUCLEAR REACTIONS. Philo T. Farnsworth (to International Standard Electric Corp.). German Patent 1,177,260. Sept. 3, 1964. Filed Mar. 11, 1960.

The electrical discharge vessel includes an electron-transparent anode having a closed surface, e.g. a spherical surface, which is entirely surrounded by a cathode. The anode is shaped in such a way that the electrons are focused into a point lying within the anode so that a negative space charge (virtual cathode) is obtained. The ions move through this localized virtual cathode. (Gmelin Inst.)

Plasma Physics and Thermonuclear Processes

Refer also to abstracts 4876 and 5056.

5264 (JUL-180-PP) UBER DEN BEWEGUNGSVORGANG IN EINEM LINEAREN PLASMABESCHLEUNIGER. (The Movement Process in a Linear Plasma Accelerator). Armin Kaleck (Kernforschungsanlage. Institut fur Plasmaphysik, Julich, Germany). July 1964. 61p. Dep.(mn).

The movement course in a linear plasma accelerator, whose outer circuit is closed by means of the accelerating plasma, is considered on the basis of three models. The

equations of motion for the three models, free-particle model, snow-plow model, and model with constant mass, were integrated numerically with the help of the IBM 1620 electronic computer. In the model with the constant mass necessary friction coefficients for consideration of individual interaction processes of the plasma with the neutron gas were estimated. The motion equations derived and the numerical results are discussed. The dependence of the dynamic size on the circuit data and the dimension questions are discussed on the basis of qualitative assumptions, which are independent of the individual model, since the motions, with some restrictions, are very similar for all three models. Graphs of the movement course are presented. (tr-auth)

5265 (JUL-Bibl-6) CHRONOLOGISCHE BIBLIOGRAPHIE DER MHD-EXPERIMENTE MIT FLUSSIGEN METALLEN UND ELEKTROLYTEN. (Chronological Bibliography of MHD Experiments With Liquid Metals and Electrolytes). H. A. Claassen (Kernforschungsanlage, Jülich, Germany). June 1964. 16p. Dep.(mn).

References on hydromagnetic experiments with liquid metals and electrolytes, as well as the basic questions of magnetohydrodynamics are presented. (132 references). (M.C.G.)

5266 (NP-14385) ANNUAL REVIEW [ON PLASMA PHYSICS], APRIL 1963–MARCH 1964. (Nagoya, Japan. Univ. Inst. of Plasma Physics). 60p. Dep.(mn).

Progress is reported in development of a machine for use in preparing highly ionized plasma by preferentially eliminating the neutral particles in magnetic fields from dense discharge plasmas. Other research is reported on adiabatic compression heating of plasma and plasma heating by strong magnetic field confinement. Experimental work is reported on production of steady-state plasmas in quiescent state, wave propagation in cylindrical plasma, production of Cs plasma by ionization, space potential distribution in hollow magnetic field discharge tube, probe noises in quiescent plasmas, development of frequency resonance probes, studies of anomalous radiation at electron cyclotron resonances, and studies of microwave radiation at the electron cyclotron harmonics. Theoretical investigations are reported on the nonlinear Alfvén wave, shapes of spectral lines from plasmas, radiations from oscillators moving across waveguides, turbulent phenomena in plasmas, and stability of galactic spiral arms. (J.R.D.)

5267 (NRL-6125) RIGOROUS TREATMENT OF THE PROPAGATION AND DAMPING OF SMALL-AMPLITUDE PLASMA WAVES IN AN INITIALLY MAXWELLIAN PLASMA. A. W. Saenz (Naval Research Lab., Washington, D.C.). Aug. 28, 1964. 21p. (AD-607397) $0.50 (OTS).

A mathematically rigorous investigation of the dispersion relation for small amplitude plasma oscillations of definite wave-number vector, which are excited in an initially Maxwellian plasma, was made. Work was done within the domain of the usual linearized Vlasov theory with attention mainly on the case in which the dimensionless quantity $\alpha \equiv (r_D k)^2$ is a small enough positive number, r_D being the pertinent Debye length and k the magnitude of the wave-number vector of the plasma oscillation of interest. The study was performed in the limit $\alpha \to +0$ of the so-called Landau denominator or plasma dispersion function $\Delta(z) \equiv 1 + \alpha - \pi^{\frac{1}{2}} z e^{z^2} \operatorname{erfc}(z)$ corresponding to such a plasma. It is shown that in this limit $\Delta(z)$ has exactly two zeros (complex conjugates of one another) in the half-plane Re $z < 0$, which lie closer to the imaginary z axis than all the other zeros of $\Delta(z)$ in this half-plane. Rigorous asymptotic formulas for the real and imaginary parts of these two nearest zeros for $\alpha \to +0$ are developed. As expected, these formulas agree essentially, but not exactly, with the corresponding results found by Landau some eighteen years ago. The discrepancy arises in the factor $e^{-\frac{3}{2}}$, which occurs in our formula for the imaginary part of these nearest zeros in the cited limit, the absolute value of this imaginary part being proportional to the Landau damping rate. Results for the location of the zeros in question agree with results obtained by other authors by nonrigorous methods. (auth)

5268 (PAN-504/IX-A) DVOINOI LENGMYUROVSKII ZOND V IMPUL'SNOI PLAZMENNOI USTAHOVKE. (The Double Electrostatic Probe with Plasma Pulse Assembly). S. Khvashchevski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1964. 11p. Dep.

The design and measuring circuit of a double probe with plasma pulse accelerator are described. The electron temperature and plasma density were measured. (auth)

5269 (R64SD54) AN EXACT CALCULATION OF MOMENTUM AND ENERGY EXCHANGE COLLISION INTEGRALS OVER DISPLACED MAXWELLIAN DISTRIBUTION FUNCTIONS. John M. Smith (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Aug. 1964. Contracts AF 33(657)-8298 and AF49(638)-914. 34p. (AD-607333) $2.00 (OTS).

The details are given of the exact evaluation of the momentum and energy exchange collision integrals for particles interacting through a potential that depends upon some arbitrary power of the interparticle distance and for displaced Maxwellian distribution functions possessing different temperatures and mean velocities. A discussion of the applicability of the calculation in the framework of the solution of the Boltzmann equation is presented and the results are applied to electron conduction in the presence of strong electric fields with emphasis on electron run-away. (auth)

5270 (SU-247-6) AN ARC PLASMA GENERATOR FOR THE STUDY OF PARTIALLY IONIZED GASES. Richard E. Steere (Stanford Univ., Calif. Nuclear Technology Lab.). June 1964. Contract AT(04-3)-247. 94p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The design and operation of an electric arc plasma generator are discussed. (R.E.U.)

5271 (TID-21252) THERMONUCLEAR PLASMA STUDIES. Quarterly Status Report No. 6. (Wisconsin. Univ., Madison). July 31, 1964. Contract AT(11-1)-1233. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Observations of plasma motion in the toroidal octupole using Langmuir probes are reported. A single-particle energy analyzer was tested along with r-f equipment. An inductive conical injection gun is being developed. An alternating gradient pipe was designed for extraction of ions from deep inside plasmas. (J.R.D.)

5272 (UCRL-11619) ABSORPTION OF ION CYCLOTRON WAVES (thesis). Gordon Wayne Hamilton (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1, 1964. Contract W-7405-eng-48. 93p. Dep.(mn); $3.00 (cy), 2(mn) OTS.

A torsional hydromagnetic wave is induced by application of an oscillating radial electric field to a cylindrical deuterium plasma in a magnetic mirror field. The wave propagates axially to the center of the chamber where a resonance occurs between the hydromagnetic-wave frequency and the ion cyclotron frequency. Ninety percent of the energy is absorbed from the wave and is transformed to kinetic energy of charged particles. Measurements of the wave magnetic field, the oscillator power, and the plasma-energy content indicate an overall efficiency of 60 to 80% energy transfer. A numerical model was constructed to study the wave propagation and damping in a magnetic mirror field under spatially nonuniform plasma conditions, subject to boundary conditions closely modeled after the experiment. The model is based upon the macroscopic equation of motion, the generalized Ohm's law, the wave equation, and the effects of ion cyclotron damping and damping by collisions between deuterons and other particle species. The equations are solved numerically by a single-line block over-relaxation technique. The numerical results show amplitudes and phases of wave currents and wave electric and magnetic fields throughout the chamber. A torsional wave is excited between the coaxial electrodes, and evanescent compressional waves are induced in the volumes defined by flux lines intersecting the electrodes. Reflections from the resonance are found when ion cyclo-

tron damping is inefficient; for example, when (because of low densities) the wavelength is too long relative to the magnetic-field gradient. (auth)

5273 (AEC-tr-6509) COLLECTIVE PROCESSES AND SHOCK WAVES IN RAREFIED PLASMA. R. Z. Sagdeev. Translated from a publication of the Institute of Nuclear Physics, Siberian Branch, Academy of Sciences, USSR, Novosibirsk, 1963. 77p. Dep.(mn); $3.00(cy) 2(mn) OTS; $7.60(fs), $2.51(mf) JCL.

The theory of collective processes for a rarefied plasma is applied to shock wave propagation. A collisionless theory for shock waves is developed by considering times less than a mean free path in the plasma. The collisionless theory is used to describe various plasma oscillations and waves. (R.E.U.)

5274 (AEC-tr-6518) PLASMA DIAGNOSTICS. COLLECTION OF ARTICLES. B. R. Konstantinov, ed. Translation of "Diagnostika Plazmy, Sbornik Statei," (a Publication of the State Publishing House of Literature of Atomic Science and Technology, State Committee for the Utilization of Atomic Energy, USSR, Moscow, 1963). Dep.; OTS.

Spectroscopic, microwave, corpuscular, probing, bolometric, and other methods of investigating plasma are discussed in 35 papers. Separate abstracts were prepared for 34 papers; the remainder was previously abstracted for NSA 18: 19140. The original Russian book was previously abstracted for NSA 18: 15405. (R.E.U.)

For abstracts of individual papers see: 4433, 4434, 4487, 4488, 5275, 5276, 5277, 5278, 5279, 5280, 5281, 5282, 5283, 5284, 5285, 5286, 5287, 5288, 5289, 5290, 5291, 5292, 5293, 5294, 5295, 5296, 5297, 5298, 5299, 5300, 5301, 5302, 5303, and 5304.

5275 (AEC-tr-6518(p.3-9)) A SPECTROSCOPIC METHOD OF MEASURING PROTON ENERGY IN PLASMA CONDENSATIONS. L. A. Dushin, I. K. Nikol'skii, and O. S. Pavlichenko. (Translation).

A spectroscopic method is proposed for the measurement of the energy distribution of protons in plasmoids. It is free of some of the shortcomings of existing methods in that it does not require that the plasmoid be taken out of the working volume to the analyzer. The bremsstrahlung and recombination-radiation spectra of the plasmoid are investigated in this method directly, and the proton energy from a Penning ion source is also measured. The procedure can be used to measure the distribution of the proton energy in plasmoids having a density exceeding 10^{13} cm^{-3} and an energy exceeding 100 ev. The tests were made with a continuous Penning discharge in hydrogen and in a longitudinal magnetic field reaching 3500 Oe, at source voltage up to 2 kv. The spectral distribution of the radiation intensity near the H_β line with λ = 4,861 Å was measured. It is shown that the density of the ions in the plasmoid can be determined if the exact values of the charge-exchange cross sections at the excited levels are known. The plasma density can also be estimated from the Stark broadening of the line. The experimental maximum in the velocity distribution corresponded to an estimated proton energy of 30 Mev. The maximum shifts towards higher energy with increasing voltage and with decreasing pressure. (JPRS)

5276 (AEC-tr-6518(p.10-19)) INVESTIGATION OF INJECTION AND COMPRESSION OF A PLASMA BY MEANS OF AN ELECTRON-OPTICAL TIME LENS. M. I. Pergament, V. I. Vasil'ev, V. S. Komel'kov, and S. S. Tserevitinov. (Translation)

The injection and pinching of a plasma were investigated by means of an electron-optical "time magnifier" technique developed earlier. A series of photographs was taken at a rate of 10^5 to 5×10^6 frames per second and an exposure of 5×10^{-8} to 5×10^{-6} sec. The series consisted of 4, 8, or 16 frames spaced 0 to 10^{-4} sec apart. Each frame measured 5 × 5 mm and the resolution time was 30 pairs of lines per millimeter. The adjustment necessary to obtain optimal conditions of the "time magnifier" are described in detail. Some of the data obtained in the photographs are compared with oscillograph data. On the basis of an analysis of both the photographs in the oscillograms it is suggested that the plasmoid consists of three principal parts: non-glowing highly ionized region; a region of intense impurity emission; and a region detached from the two walls, with bright deuterium lines, having a conical front. The latter region should have a low temperature, (i.e., weak ionization), because it does not crowd out the magnetic field well. These conclusions are confirmed by a study of the time variation of the intensities of the individual spectral lines at different points of the plasma loop, using a monochromator with a photomultiplier. The pinching of an injected plasma by rapidly growing fields and a study of a plasma injector based on the "gushing pinch" were also investigated by this technique and it is shown that it provides information not readily available by other means. (JPRS)

5277 (AEC-tr-6518(p.20-7)) MEASUREMENT OF SOFT X-RAY RADIATION OF A NON-CYLINDRICAL Z-PINCH. T. I. Filippova and N. V. Filippov. (Translation)

The soft x-ray emission from a plasma (λ = 5 to 15 Å) was measured with a pulsed installation similar to that used to investigate z-pinches. A plasma was produced in deuterium at 1 mm Hg pressure by a discharge current with a rise-time (6 to 7) × 10^{11} amp/sec, reaching a maximum of 500 kamp within approximately 3 μsec. A feature of such a discharge is the non-cylindrical collapse of the current sheath towards the axis, so that maximum plasma compression occurs near the anode. The compression focus serves as a highly localized source of hard radiation (neutrons and protons) and is simultaneously characterized by a powerful flash of continuous spectrum in both the visible and the soft x-ray regions. The radiation was measured photographically and by photoelectric means. The measurement procedure is described in detail. Comparison of the experimental data with the calculations shows that the particle densities in the region, which emits the soft x radiation, is of the same order ($n \sim 10^{19}$ cm^{-3}) as that measured in the visible continuum region (~7×10^{18} cm^{-3}), and that the maximum electron temperature lies in the interval 0.8 to 1.2 kev. The temperature distribution along the axis of the pinch was plotted as a function of the distance from the negative electrode by measuring the density ratios of photographs obtained behind different filters. The temperature values obtained for different density combinations agreed quite well. It is pointed out that the continuity and monotonicity of the x-ray spectrum was not verified with sufficient reliability. (JPRS)

5278 (AEC-tr-6518(p.33-8)) ON THE POSSIBILITY OF LASERS FOR PLASMA DIAGNOSTICS. V. V. Korobkin. (Translation)

The use of continuous-action gas lasers as radiation sources for plasma electron diagnostics using interferometric techniques is discussed. (R.E.U.)

5279 (AEC-tr-6518(p.59-64)) SPECTROSCOPIC DETERMINATION OF THE ELECTRON TEMPERATURE OF A PLASMA UNDER CONDITIONS OF A WEAK ESCAPE OF THE ELECTRONS. Yu. N. Zhivlyuk. (Translation)

The method is based on the definite connection existing between the level population and the average electron energy (inelastic collisions of the second kind between the electrons and the ions, and absorption of radiation, are neglected). The case of weak runaway of electrons in the electric field is considered, when the electron velocity distribution function is constant inside a velocity-space cylinder bounded by the upper and lower runaway boundaries. It is shown that even weak runaway of electrons causes the electron velocity distribution function to deviate from Maxwellian and result in incorrect values of the temperature. The limits within which Maxwellian distribution can still be employed are given. It is also shown that weak runaway of electrons does not influence the plasma conductivity. (JPRS)

5280 (AEC-tr-6518(p.65-73)) A METHODOLOGY OF MEASURING THE MEAN ELECTRON DENSITY IN A PLASMA WITH "TOKAMAK" INSTALLATIONS. E. P. Gorbunov. (Translation)

A method is described for measuring the average electron density in a plasma pinch during the entire discharge time. It is based on determining the average electron density from the phase shift of microwaves propagating through a plasma. The phase is determined in turn by mixing in a crystal detector the power received from a microwave generator and flowing in the two arms of an interferometer, one without and one with plasma. The method is essentially the same as described by Wharton (Second Geneva Conference, 1958) and can be used to measure an average electron density in the range 5×10^{11} to 7×10^{13} cm^{-3} in plasma devices such as "Tokamak." The upper limit of the range is several times lower than the critical density. The resolution of the interferometer is determined by the time interval between the neighboring bright spots of the interference pattern produced on the oscilloscope screen. When the best resolution is obtained, this time amounts to 2 microseconds. The use of a narrow-band amplifier for the interference signal increases the sensitivity and interference immunity of the system. A shortcoming of the method is that only average concentrations are obtained. (JPRS)

5281 (AEC-tr-6518(p.91-8)) INVESTIGATION OF THE SPATIAL DISTRIBUTION OF PARTICLES OF A DECAYING PLASMA. A. I. Anisimov, N. I. Vinogradov, and V. E. Golant. (Translation)

Curves showing the spatial distribution of charged particles in a decaying plasma in the concentration range 10^{12} to 10^{13} cm^{-3} are obtained from previously reported experimental data. It is shown that the procedure for the determination of the spatial distribution of the charged particles used in this research can be greatly improved in the case of a decaying plasma, because the charge-particle distribution remains practically the same at the later stages of the plasma decay. A theoretical procedure for processing the experimental data is derived on the basis of the geometrical optics approximation, and the resultant curves are confirmed by data on the spatial distribution of the plasma glow, showing that the experimental results are in agreement with the theory of plasma decay. (JPRS)

5282 (AEC-tr-6518(p.99-106)) MEASUREMENT OF THE DIAMETER OF A PLASMA COLUMN WITH A VELOCITY PHASEMETER. L. Ya. Malykh, N. I. Malykh, N. F. Perepelkin, L. A. Ushkina, and E. S. Yampol'skii. (Translation)

A procedure is described for measuring the diameter of a reflecting cylindrical plasma surface with density 1.7×10^{13} cm^{-3} by means of a velocity phase-meter. The connection between the phase of the reflected signal and the position of the reflecting surface is established for the instant of the time when the density on the axis of the plasma column passes through the critical value. To determine this connection it is necessary to know the maximum phase of the reflected signal and the form of the distribution of the electrons along the radius of the chamber. The laboratory apparatus used for the purpose is described, and the applicability of the theoretical estimate to practical installations is evaluated. It is shown that when the distance to the plasma is smaller than 70% of the radius, the form of the distribution function influences little the dependence of the phase of the reflected signal on the position of the reflecting surface, so that the proposed method is suitable when the distribution is constant during the time of the measurements, at least if the distance exceeds 70% of the radius. (JPRS)

5283 (AEC-tr-6518(p.107-11)) A METHOD OF DETERMINING THE CONCENTRATION GRADIENT OF A PLASMA BASED ON THE DIFFRACTION OF ELECTROMAGNETIC WAVES. A. D. Piliya. (Translation)

The scattering of an electromagnetic wave by a plasma cylinder is considered under the condition that the plasma concentration near the cylinder axis is large compared with the critical concentration, and that $ka \gg 1$ (k—wave number, a—radius of cylinder). In this case the scattering has a diffraction character and is determined by a single parameter, namely the concentration gradient on the plasma boundary, which can be determined by measuring waves scattered from a dielectric cylinder filled with plasma. The method is the same, with slight modification, as used by V. A. Fok for diffraction on a sphere. (JPRS)

5284 (AEC-tr-6518(p.112-17)) THE APPLICATION OF LONGITUDINAL PROPAGATION OF RADIO WAVES FOR PLASMA DIAGNOSTICS. L. A. Dushin, V. I. Privezentsev, and A. I. Skibenko. (Translation)

It is shown that the density of the plasma can be determined by measuring the phase shift of a radio wave transmitted through the plasma. The propagation of the signal in the ionized plasma in the magnetic field is characterized in the case of longitudinal propagation by the phase and group velocities of the signal. Consequently, by measuring the delay time of the signal it is possible to determine the electron density at a given instant of time. Experiments were performed using a pulsed source with a molybdenum-glass discharge tube 10 cm in diameter and 130-cm long. The magnetic field could be varied from 0 to 8000 Oe. A 550 Mc signal was used, and helical antennas were used for the radiation and reception of the signal. The time dependence of the average density was determined from oscillogram patterns of signals of wavelengths 55 cm for longitudinal propagation and 8 mm for transverse propagation of the extraordinary and ordinary waves (magnetic fields 1400 Oe, pressure approximately 10^{-2} mm Hg, sweep duration 1200 μsec). The results obtained (delay 0.12 μsec, density 2×10^{14} cm^{-3}) agree well with theory and also with other experiments. (JPRS)

5285 (AEC-tr-6518(p.118-25)) DEVELOPMENT OF THE METHOD OF MEASURING THE MAXIMUM ELECTRON DENSITY IN A PLASMA FROM THE "CUTOFF" OF MILLIMETER WAVES. V. V. Rozhdestvenskii. (Translation)

The proposed improvement of the method is based on a continuous comparison of the plasma frequency of the investigated discharge with the known frequency of a microwave sweep generator, and on a determination of the instants of time when these frequencies become equal. This establishes the variation of the plasma frequency or of the maximum electron density as a function of the time. The indication can be effected by a microwave signal either reflected from the plasma or transmitted through it. A measuring setup was developed for a practical realization of this method; its construction, and operation of the main units are described in detail. The measurements were made at 4 mm wavelength, and the experiments show that if the receiving and transmitting system is well adjusted, the size of the focal region becomes comparable with the wavelength. The use of this procedure in plasma diagnostics is limited by such characteristics of the measuring apparatus as the bandwidth, measurement precision, sensitivity, resolution, and operating speed. The effects of the apparatus parameters on these characteristics are briefly mentioned. The proposed procedure is compared with known interferometric methods. When both methods are applicable, the interferometric method yields the time dependences of the average electron density, whereas the proposed method gives the time dependence of the maximum density. The proposed procedure can be used for plasma pinches of small or time-varying diameter, when an interferometer cannot be used. (JPRS)

5286 (AEC-tr-6518(p.126-36)) APPLICATION OF RADIOMETERS IN THE MICROWAVE RANGE FOR INVESTIGATING A PLASMA. M. M. Larionov. (Translation)

Problems connected with the construction of apparatus for the investigation of microwave radiation from a hot plasma are considered. Radiometers of the direct amplification and of the superheterodyne type are described. The sensitivities of both types are compared and it is shown that both have sufficient sensitivity for the investigation of hot plasma having a noise temperature 10^{5}°K and above. Both types of radiometers were constructed and used to determine the electron temperature of a hot plasma in the "Alpha" apparatus. The superheterodyne radiometer was described earlier (paper CN-10/241), Conference on Plasma Physics

Research in Salzburg, 4 to 9 September, 1961). The direct amplification radiometer was constructed for detailed research on the radiation spectrum in the short-wave part of the band. Some considerations involved in the design of the amplifier are discussed briefly. The radiometer was used to record radiation from the plasma at 8 and 4 mm, at which its sensitivity was $10^{4\circ}$K at a bandwidth of 10 kc (compared with 2500°K at a wavelength 8.2 mm and a filter bandwidth 50 kc in the case of the superheterodyne radiometer). (JPRS)

5287 (AEC-tr-6518(p.137-45)) THERMAL RADIATION OF A PLASMA ENCLOSED IN A CHAMBER WITH REFLECTING WALLS. A. N. Karkhov and V. T. Karpukhin. (Translation)

A procedure is outlined for determining the temperature of plasma electrons from the quality factor Q of the metal vacuum chamber used for the experiments, which is treated in this case as a cavity resonator. The formulas derived on this basis were used to determine the temperature of the electrons in the positive column of a discharge with incandescent cathode in a homogeneous magnetic field in a copper chamber, with the radiation frequency (9350 Mc polarized parallel to the external magnetic field) measured by a superheterodyne receiver. The electron density was measured with an interferometer at a wavelength of 8 mm. In addition, the electron temperature was determined with a probe. The Q of the vacuum chamber was determined with a noise generator. The experimental results show that the electron temperature cannot be determined from the blackbody temperature, and also that at currents above 2 amperes and magnetic fields above 600 to 700 Oe the radiation power of the plasma increases strongly and cannot be regarded as thermal radiation. The reasons for this are not clarified. (JPRS)

5288 (AEC-tr-6518(p.146-53)) USE OF A MASS SPECTROGRAPH FOR OBTAINING QUANTITATIVE DATA CONCERNING THE COMPOSITION OF PLASMA CONDENSATIONS. I. I. Konovalov, L. I. Krupnik, I. N. Onishchenko, and N. G. Shulika. (Translation)

In order to prevent the polarization of a slow plasma and other effects from distorting the results of mass-spectrographic analysis of the plasma, an instrument is proposed in which the ion beam is drawn from the analyzed plasma and is simultaneously accelerated to 20 kev in the gap of the mass spectrograph. The energy spectrum of the plasma ions appears as a corresponding spread over this constant level. The construction of the mass spectrograph is described. The ions were registered with thin-layer emulsions that could be moved in and out of the mass spectrograph without breaking the vacuum. Individual experiments were made to study the density of the image produced on the emulsion as a function of the number of H, D, T, ^{4}He, ^{12}C, ^{14}N, and ^{16}O positive ions with energies from 10 to 20 kev. The apparatus used to calibrate the photographic emulsions is described. Various factors influencing the emulsion density are considered. The method described was used to obtain the mass-spectroscopic and energy characteristics of conical and coaxial plasma sources. It is concluded that the method can be used to extract a great variety of information on the properties and behavior of the plasma. (JPRS)

5289 (AEC-tr-6518(p.154-62)) INVESTIGATION OF A PLASMA SOURCE BY MEANS OF A FLOATING-DRIFT MASS SPECTROMETER. A. A. Kalmykov, A. D. Timofeev, Yu. I. Pankrat'ev, and M. G. Nozdrachev. (Translation)

In view of the lack of information on the internal structure of plasmoids and of a satisfactory description of the mechanism of plasma acceleration in different plasma guns, and in view of the difficulty of interpreting the experimental results on interaction between plasmoids and magnetic fields owing to the lack of this information, a method is proposed wherein more detailed microscopic characteristics can be obtained with the aid of a through-passage mass spectrometer. This mass spectrometer was used to investigate the mass and energy spectra of plasmoids from a Bostick gun. The operation of all the units of the instrument is described in another article. The conditions for optimal mass separation are described. In view of the short transit time employed, there is no need for additional modulation. The apparatus yields mass spectra of ions of given energy, from which the energy spectra of particles having different masses can be plotted. The angular distributions of the ions of different masses and energies were also investigated and it was found that ions with larger velocities form a narrower velocity cone than the slower ions. It is therefore concluded that measurement of the true energy distribution must be accompanied by measurement of the angular distribution of the particles and the number of particles of given energy must be integrated over all the angles in order to insure accuracy. The duration of the discharge exerts little influence on the energy spectra. The length of the plasmoid changes as it moves from the source because of the spread in particle velocity, and since the particle velocity decreases with increasing mass, the light ions are concentrated in the frontal part of the plasmoid and the heavy ones in the tail part. This spatial separation of the ions increases with increasing transit length. In the absence of the magnetic field the slow ions are rapidly lost because of the broad velocity cone. There are grounds for assuming that the plasmoids produced by other plasma guns, particularly coaxial, show a similar behavior. (JPRS)

5290 (AEC-tr-6518(p.163-70)) THE USE OF THE NATURAL MAGNETIC FIELD OF THE "OGRA" MAGNETIC TRAP FOR ANALYZING FAST IONS, ESCAPING FROM THE PLUGS, WITH RESPECT TO MASS AND ENERGY. G. F. Bogdanov, P. I. Kozlov, and B. P. Maksimenko. (Translation)

A simple ion mass analyzer was developed for the stream of fast ions emerging from a mirror. In addition, a spectrometer was developed for the measurement of the energy spectrum of the ions. The two instruments were located in the region of maximum of the magnetic field of the "Ogra" apparatus, which was also used to separate the ions. The analyzer was used to measure the distributions of the fluxes of atomic and molecular ions over the radius of the chamber at azimuth angles 0 and 180°. The spectrometer was used to obtain analogous distributions for 70 and 250°. These data were used to determine the fluxes of the ions emerging from the Ogra through the mirrors. It was established that the fluxes of the H_1^+ and H_2^+ ions are proportional to the current of the injected ions, and that the density of the atomic ions is higher in the unstabilized mode than would follow from data obtained with the aid of neutral-particle detectors after turning off the injected current. The spectrometer was also used to investigate the spectra of atomic and molecular ions leaving the mirror. At plasma densities above 10^6 mm cm^{-3} the ion spectra have an anomalously great width which has not yet been explained. The construction and adjustment of the apparatus are described in detail. (JRPS)

5291 (AEC-tr-6518(p.171-9)) PLASMA DIAGNOSTICS WITH RESPECT TO FAST NEUTRAL PARTICLES IN A DEVICE WITH A DISCHARGE IN A STRONG MAGNETIC FIELD. V. V. Afrosimov, I. P. Gladkovskii, and M. P. Petrov. (Translation)

In view of the large amount of information that can be obtained from a study of the flux of fast neutral atoms emitted by a plasma in toroidal-discharge installations in a strong magnetic field, an atomic analyzer was employed for the analysis of the flux of fast atoms emitted by the plasma in the "Tokamak-2 (T-2)" apparatus. The analyzer was previously described. A fraction of the fast atoms entering the instrument was converted into ions by stripping on nitrogen molecules. These ions were analyzed by energy in an electric field and then by mass in a magnetic field, after which they proceeded to the detector. The instrument was calibrated with auxiliary apparatus. The various precautions needed to insure precision are discussed. It was established that the plasma from the T-2 apparatus emits an atom flux with energy of hundreds and thousands of electron volts. A mass analysis of the secondary ions produced by stripping the nitrogen atoms has shown that about 99% of the ions are protons. The only noticeable impurity was carbon-12. The main mechanism producing this flux of fast atoms is neutralization of the plasma ions via charge-exchange with the atoms entering the plasma. The conditions for the occurrence of this flux are estimated. Preliminary measurements

of the spatial distribution of the atom flux over the volume of the chamber were also carried out and it was established that the fast-atom flux comes from all parts of the chamber. The energy distribution of the fast atoms indicates that the plasma ions have no Maxwellian energy distribution, a feature characteristic of turbulent plasma. (JPRS)

5292 (AEC-tr-6518(p.180-4)) PROBING A DEUTERIUM PLASMA WITH A TRITIUM BEAM. I. K. Kikoin, B. M. Gokhberg, V. V. Mal'tsev, G. A. Otroshchenko, and A. S. Knyazyatov. (Translation)

The method is based on the registration of the number of reactions between the incident tritium nuclei and the deuterium nuclei of the plasma, making it possible to investigate the variation of the deuterium density independently of the degree of ionization of the plasma and of the impurity contents. The investigation was made in the "Igla" toroidal chamber (large diameter 750 mm, small diameter 200 mm, maximum capacitor bank energy 35 kJ, maximum discharge current 100 kamp). The ion current and the position of the beam were monitored with thermocouples distributed over the channel. The investigation of the neutron yield from the ion collector located on the inside of the discharge chamber has made it possible to draw certain conclusions concerning the absorption of the working gas (deuterium) by the walls of the discharge chamber. However, in the case of high-frequency ionization of the gas (preliminary ionization) the walls are capable of absorbing a very large amount of gas. Investigations of the variation of the deuterium plasma density during the discharge time show that the plasma density increases by several times during the discharge, as a result of interaction between the plasma and the walls. When deuterium is used in the discharge chamber, the yield of neutrons decreases immediately after the discharge, compared with the yield in the absence of discharge. In the case of hydrogen, the opposite takes place. A control experiment has shown that the increase in the neutron yield is not due to a displacement of the ion beam during the discharge. (JPRS)

5293 (AEC-tr-6518(p.185-95)) PLASMA DIAGNOSTICS BY MEANS OF BEAM OF ATOMS OR IONS. O. V. Kozlov, A. M. Rodin, V. D. Rusanov, Yu. A. Skoblo, and A. V. Chernetskii. (Translation)

Apparatus is described for the probing of a plasma of an oscillating discharge in gas by means of accelerated and focused ion beams or by means of charge-exchanged atom beams. Formulas are derived for the attenuation of ion beams in gases and are found to be in good agreement with experiments for the pairs $Ar^+ \rightarrow Ar$, $He^+ \rightarrow He$, $H^+ \rightarrow H_2$, $He^+ \rightarrow Ar$, and others. The discrepancy between the experimental and calculated data becomes appreciable at high pressures. The limiting pressure amounted to (2 to 3) $\times$ 10^{15} cm^{-2} for the pair $Ar^+ \rightarrow Ar$ with Ar^+ energy 10 kev and about 10^{16} cm^{-2} for the $H^+ \rightarrow H_2$ pair. Analogous results were obtained by measuring the broadening of the lines of the magnetic-analyzer spectrum. Measurements were also made of the dependence of the ion density on the discharge current. Apparatus was developed for the study of magnetosonic resonance and used to measure the attenuation of atomic argon beams in a hydrogen plasma, atomic helium beams in a helium plasma, and atomic argon beams in helium plasma. It is concluded that in spite of certain difficulties, the method of determining plasma parameters by means of beams of fast particles is worthy of serious attention, since it has undisputed advantages (practical elimination of contacts, locality of probing, wide range of measured quantities, and possibility of quantitative determination of the plasma composition). It is also concluded that atomic beams are more suitable for the determination of characteristics of charged particles. The operating speed of measurements with particle beams can be made quite high, with a low resolution time. (JPRS)

5294 (AEC-tr-6518(p.196-204)) INVESTIGATION OF PLASMOIDS BY A BEAM OF FAST NEUTRAL ATOMS. L. I. Krupnik and N. G. Shulika. (Translation)

An experimental setup was constructed making it possible to probe hydrogen plasmoids by means of a beam of fast neutral hydrogen atoms. The operation of the apparatus is described and the effect of the presence of un-ionized gas molecules in the plasma and of heavy-ion and heavy-atom impurities in the plasma is analyzed. A Thompson mass spectrometer was used to monitor the purity of the plasma (permissible impurity content 20%). The method was employed to study the density and structure of a plasmoid produced by a conical plasma source. The quantities measured were the attenuation of the neutron beam in the chamber without a discharge, the interaction between the neutral beam and the plasmoid, the interaction between the neutral beam and the frontal part of the plasmoid, the dependence of the plasmoid density on the plasma source voltage, and the effect of the magnetic field on the density of the plasmoid traveling through a large distance. At a density of approximately 10^{15} cm^{-3} the attenuation of the sounding beam reached 70 to 80%. The measurement error does not exceed 20%. (JPRS)

5295 (AEC-tr-6518(p.205-13)) THE USE OF ELECTRON AND ION BEAMS TO MEASURE THE ELECTRIC FIELD OF THE SPACE CHARGE OF A PLASMA IN THE "OGRA" DEVICE. Yu. A. Kucheryaev and D. A. Panov. (Translation)

Two methods are described for measuring the field of plasma space charge. In one method the deflection of the electron beam due to drift in crossed electric and magnetic fields is measured, while in the other method the electric-field pickup is a beam of cesium ions moving in the boundary region between the plasma and the chamber wall. The measurements were aimed at determining the field distributions and the collective processes occurring in an "Ogra" device. The electron source used was a three-electrode gun placed in one of the magnetic mirrors of the Ogra, and the electron beam receiver was a television-tube screen with low persistence. The construction and operation of the apparatus are described. The quantities measured were the radial distribution of the radial component of the electric field of the plasma space charge, the electric field near the walls of the chamber, and the correlation of the electric field near the cesium probe with the signal from the fast-ion detector. It is concluded that the use of interaction between the probe charges and electromagnetic fields of the plasma, and also of atomic and nuclear collisions with the plasma components yields a variety of information on the plasma properties. An advantage of such diagnostics is the fact that it hardly disturbs the investigated object. (JPRS)

5296 (AEC-tr-6518(p.214-17)) MEASUREMENT OF A POTENTIAL WELL IN A PLASMA BY THE TRANSIT TIME OF CHARGED PARTICLES. O. A. Lavrent'ev, B. A. Nemashkalo, L. I. Ovcharenko, B. G. Safronov, and V. A. Sidorkin. (Translation)

A method is proposed for measuring the potential of a plasma during the time of flight of a beam of charged particles through the plasma. In the case of a dense plasma, when the Debye screening radius is small and the electric fields in the plasma are concentrated in a narrow boundary layer, methods using beams of charge particles entail experimental difficulties. The operation of the experimental setup is such that after the injection pulse is completed, the potential of the grid of the plasma gun becomes lower than the cathode potential, and the electrons are locked in a trap. The plasma is produced as a result of ionization of the residual gas by the electrons. The potential well is measured by passing a modulated beam of krypton ions through the plasma. The time dependence of the plasma potential is determined from oscillograms, which slow the phase shift of the ions in the beam. (JPRS)

5297 (AEC-tr-6518(p.218-26)) INVESTIGATION OF THE PARAMETERS OF A PLASMA IN A STRONG MAGNETIC FIELD BY MEANS OF DOUBLE ELECTRIC PROBES. I. A. Kovan, Yu. L. Moskvin, V. D. Rusanov, and V. P. Smirnov. (Translation)

The reliability of double-probe measurements in electrodeless discharges in strong magnetic fields was investigated. Electron-temperature diagnostics by the double-probe method were compared with results obtained using

spectral, microwave, and other techniques. The plasma source for experimental study was a pulsed h-f discharge in hydrogen or helium or a mixture of hydrogen and helium. The discharge chamber was placed in static magnetic fields of 0 to 3.5 kOe and in pulsed magnetic fields of 0 to 15 kOe. (R.E.U.)

5298 (AEC-tr-6518(p.227-34)) APPLICATION OF RETARDING-POTENTIAL METHOD FOR STUDYING THE ENERGY DISTRIBUTION OF CHARGED PARTICLES IN AN "ALPHA" DEVICE. B. V. Galaktionov and K. A. Dolmatova. (Translation)

A new type of analyzer, essentially an isolated probe introduced into the plasma, was developed for the determination of the energy distribution of plasma charged particles. The particle energy connected with the axial velocity component in a diaphragm is analyzed with the aid of a retarding potential applied to the analyzing grid. The apparatus was used to determine the dependence of the energy distribution of the ions and electrons on the discharge parameters (capacitor-bank voltage, hydrogen pressure in the liner, dependence of the ion energy on the distance to the liner). The operation and the characteristics of the equipment are described. The measurements lead to the following conclusion: (1) The energy distribution of the charged particles from the "Alpha" apparatus plasma is close to Maxwellian in the energy range up to 400 ev. (2) The measured temperature of the ion component of the plasma depends on the discharge parameters and on the distance from the liner wall, and ranges from 20 to 130 ev, increasing with increasing distance from the liner and with decreasing pressure. (3) The measured electron temperature has the same dependence on the discharge parameters, and ranges from 40 to 100 ev. The electron temperature and its pressure dependence agree with the values determined from the noise temperature, but disagree with the values obtained spectroscopically. (JPRS)

5299 (AEC-tr-6518(p.235-40)) ON THE USE OF A PLASMOSCOPE FOR VISUAL OBSERVATION OF THE BEHAVIOR OF A DENSE PLASMA IN A LONGITUDINAL MAGNETIC FIELD. L. I. Krupnik and N. G. Shulika. (Translation)

An apparatus (plasmoscope) for visual observation of plasma formations of low density (10^{10} to 10^{11} cm^{-3}), first described by another author, was modified slightly to observe the behavior of dense plasmoids (up to 10^{15} cm^{-3}) moving in a longitudinal magnetic field. The optimal plasmoscope parameters necessary for the purpose are established and the dependence of the diameter of the dense part of the plasmoid on the magnetic field applied along the plasmoid propagation axis was determined by photography. It was found originally that in magnetic fields with H > 800 Oe, the plasmoid remained practically constant in diameter. However, a recheck on the result, by reducing the number of grounded grids and thereby increasing the density of the plasma reaching the scintillator, showed that the diameter decreases with decreasing number of attenuating grids. In an attempt to explain this fact it is suggested that with decreasing number of grids a larger current charges the plasmoscope capacitor before the bulk of the plasma reaches it. This hypothesis was checked experimentally by using different capacitors in the plasmoscope supply circuit. The results confirm the assumptions that the plasmoid increases from its "head" towards its "tail" and predicts the possibility of determining the variation of the plasmoid cross section along its length by applying short duration voltage pulses to the plasmoscope. (JPRS)

5300 (AEC-tr-6518(p.241-7)) APPLICATION OF A LUMINESCENT PROBE FOR RECORDING A MOVING PLASMA. G. M. Batanov, M. A. Ivanovskii, O. I. Fedyanin, and I. S. Shpigel'. (Translation)

The plasmoscope method for visual observation of plasma behavior in magnetic field was modified for study of plasma density in a jet moving perpendicular (laterally) to a luminescent screen. The luminescent screen (probe) consists of a phosphor-coated glass disk with screening grids. Consideration is given to the distorting effects of the probe, which completely blocks the path of the jet and may provide a region of afterglow. (R.E.U.)

5301 (AEC-tr-6518(p.248-51)) INVESTIGATION OF A PLASMA IN THE "OREKH" MAGNETIC TRAP BY MEANS OF SPECIAL BOLOMETERS. L. L. Gorelik, N. G. Koval'skii, I. M. Podgornyi, and V. V. Sinitsyn. (Translation)

The spatial and temporal distributions of heat flow from the wall of a magnetic-trap vacuum chamber with a field that increases towards the periphery were investigated to ascertain the influence of the region near the point of zero field in the escape of charged particles at low plasma concentrations, and also the character of time variation of the width of an annular magnetic slot. Several specially developed bismuth bolometers were used to measure the heat flow from an "Orekh" magnetic trap. The bolometer constructions are described. Measurements of the magnetic gap have shown that the width of the gap is larger at small values of the magnetic field, and the experimentally observed broadening of the magnetic gap can be sufficiently well explained by classical diffusion. The escape of plasma particles was measured by introducing a metallic cylinder into the trap and measuring the heat escaping through the magnetic gaps with germanium bolometers. In the case of the first configuration of the magnetic field in the trap, it was found that the particle escape from the system is due to loss of the adiabatic invariant on entering the region of weak magnetic field near the center, whereas in the case of the second configuration the plasma is essentially concentrated in the region of the weak magnetic field near the center. Thin-film bolometers were also used to measure the escape of heat from the trap for plasma of high (~10^{14} cm^{-3}) and low density (10^{12} cm^{-3}). The escape times were found to be 60 to 70 and 150 to 200 microseconds, respectively. The bolometers described can be used to solve various problems in plasma physics. (JPRS)

5302 (AEC-tr-6518(p.252-9)) MEASUREMENT OF THE ENERGY OF A PLASMA IN TIME. Yu. G. Prokhorov, V. F. Demichev, and V. D. Matyukhin. (Translation)

A system, called "thermal probe," was developed to measure the time variation of plasma energy. It consists of a platinum foil 6 microns thick, heated electrically to 1,000 to 1500°C, the incandescence of which is registered by a photomultiplier with maximum sensitivity in the red part of the spectrum (near 7,000 Å). The spectral sensitivity of the foil-plus-photomultiplier system, with the foil electrically heated, is sufficient for the registration of a slight change in the foil temperature such as is produced by the heating of the plasma. The instrument is calibrated by discharging a capacitor through the foil. The thermal probe was used to measure the plasma energy in slow (millisecond) and fast (microsecond) processes, as well as to estimate the efficiency of thermal insulation of the plasma column in a toroidal system with longitudinal magnetic field ("Tokamak"). It was also used to measure the energy of fast plasmoids obtained with the aid of a coaxial plasma gun. In the latter case such a measurement is preferable because the usual calorimetric method determines only the integral energy of the plasmoids occurring in one discharge, without giving the energy in individual plasmoids. The use of the thermal probe in conjunction with other methods (electric probe, millimeter waves transmitted through the plasma, etc.) makes it possible to determine a large number of parameters of plasmoids produced in a single discharge. Another feature of the apparatus is that there is no direct electric connection between the plasma and the recording apparatus, which can be located away from the plasma. The thermal probe can also be used in chambers with high initial vacuum. (JPRS)

5303 (AEC-tr-6518(p.260-5)) EXCITATION OF PLASMA OSCILLATIONS BY AN ION BEAM AND THE POSSIBILITY OF DETERMINING ELECTRON TEMPERATURE. M. D. Gabovich, G. S. Kirichenko, and V. S. Koidan. (Translation)

Apparatus aimed at checking the influence of electron drift in a direction opposite to the ion beam on the stability

of the oscillations produced when an ion beam passes through a plasma is described. It is reported that, unlike earlier experiments, oscillations with noticeable amplitude were excited also in the absence of drift current. The properties of these oscillations are described briefly. In the presence of backward drift, a new type of more intense oscillation with a rather narrow frequency spectrum was also observed. It is concluded that the backward electron drift leads to establishment of a standing wave, to a considerable increase in the oscillations, and to a narrowing down of the frequency range. The ion threshold energy at which the excitation of these oscillations terminates is proportional to the electron temperature. This is in qualitative agreement with the theory and gives grounds for assuming that a new method will be developed for determining electron temperature. It is proposed in the future to broaden the range of electron temperatures of the investigated plasmas and also to carry out a rigorous quantitative determination of the threshold energy. (JPRS)

5304 (AEC-tr-6518(p.266-73)) MEASUREMENT OF THE DISTRIBUTION OF CONDUCTIVITY IN A PLASMA STRING. D. P. Ivanov and S. S. Krasil'nikov. (Translation)

It is proposed to determine the radius of a plasma pinch (filament) from the distribution of its conductivity, by superimposing an additional high-frequency component on the voltage exciting the discharge, such that the reactance of the pinch relative to the supplementary frequency is much larger than the resistance. The inductance and consequently also the geometrical dimensions of the pinch can then be determined from the ratios of the amplitudes of the supplementary component on the circuit voltage and on the derivative of the current. A similar method was used by K. V. Donskoy, et al., for investigation of conductivity in gas jets. The plasma pinch is assumed to be axially symmetrical. The dependence of the measured inductance on the frequency of the supplementary oscillations is qualitatively estimated for different distributions of the conductivity over the cross section of the plasma pinch, and it is concluded that the method can be used for estimates of the conductivity in the outer zone of the plasma pinch and of irregularities in the distribution of the conductivity over the cross section, and for approximate measurements of the internal high-conductivity zone. The approximate radius of the current and its time variation can be derived from these estimates. It is emphasized that the results are still preliminary. (JPRS)

5305 DELAYS IN INITIATION OF DISCHARGES IN PULSED PLASMA ACCELERATORS. Leonard Aronowitz (Grumman Aircraft Engineering Corp., Bethpage, N. Y.) and Warren Coe. AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2019-20(Nov. 1964).

The efficiency of propellant utilization in pulsed plasma accelerators can be markedly affected by the time interval between the injection of the gas and the time when the discharge current becomes large enough to accelerate the gas. The magnitude of the delay in a high-current discharge was investigated, and it was concluded that the observed delays apparently were caused by statistical lags in the initiation of the discharges rather than lags in current buildup after initiation. (C.E.S.)

5306 A COMPATIBILITY EQUATION FOR NON-EQUILIBRIUM IONIZATION. F. H. Shair (General Electric Co., Philadelphia). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2026-7(Nov. 1964).

An expression of compatibility, independent of the electron collision frequency, is developed from the electron heating equation and the Saha equation. By using this compatibility relation, one may compute the profiles of electron temperature, plasma electric conductivity, and electric field between the anode and cathode of moderate pressure plasma devices once the neutral particle temperature profile and the current density are measured. The current passing through any plane parallel to the electrodes is assumed constant. The influence of nonuniformities due to insulator walk is neglected. Radiation losses are neglected, and as a first approximation, electron diffusion is also neglected. (C.E.S.)

5307 THE INDUCTANCE AND ELECTRIC RESISTANCE OF IONIZED GASES. K. Mikhul. Analele Stiint. Univ. A. I. Cuza, Iasi, Sect. I, 9: 165-76(1963). (In Russian)

The conditions for the existence in an ionized gas column of periodic electrical oscillations were studied. It was shown that the period of oscillation is determined by the dimensions of the column, which enter in the expressions of the inductance and the capacity, and in the case in which the electron density is less than 10^{10} cm^{-3} and that of the ions is much less than 10^{14} cm^{-3}, also of the density of the principal charge carrier, of their mass, and of the length between two successive collisions of carriers with the gas molecules. The factor determining the character of the oscillations relative to their periodicity is the ratio $R_1/2L_1\omega$, or, if the electrical conductivity of the gas is considered, the ratio of the active component of the current maintained by the electrical field and its reactive component. This ratio depends on the length of the free movement of charge carriers. At small pressures the reactive component is sufficiently intense so that the damping of the oscillations is much smaller than the critical damping. As a result, periodic oscillations occur in which the frequency is proportional to $(N/m)^{1/2}$ since $N/m > N_i/m_i$. When the pressure increases, the contribution of the electrons to the reactive current decreases and the conditions for the existence of periodic oscillations are no longer present. Thus the oscillations cease at the frequency proportional to $(N/m)^{1/4}$. Later, when the time between two successive collisions is so small that $N_i/m_i \times T > N/m$, the oscillations begin anew; their frequency is determined by the ion density. These oscillations are maintained to very high pressures, but only up to the moment when the reactive component of the ionic current becomes weak. The regions of electron and ionic oscillations can be placed in various areas of the scale of pressures. (tr-auth)

5308 PERMANENT OPERATING CONDITIONS FOR A MAGNETIC BOTTLE WITH RESPECT TO CHARGE CARRIER TRANSVERSE DIFFUSION. J.-M. Dolique. Ann. Radioelec., 19: 81-96(Apr. 1964). (In French)

The magnitude of losses by transverse diffusion was investigated, considering a magnetic bottle (indefinite cylinder of revolution) in which losses occur only by diffusion and are compensated by continuous particle injection. The two-fluid equations were used. The density profile was determined, and several conditions for containment were established. The leakage current was then calculated, together with the mean containment time of a particle. (D.C.W.)

5309 INVESTIGATION OF OHMIC HEATING OF PLASMA IN TOROIDAL INSTALLATION "TOKAMAK-3". L. A. Artsimovich, S. V. Mirnov, and V. S. Strelkov. At. Energ. (USSR), 17: 170-6(Sept. 1964). (In Russian)

Preliminary tests of the Tokamak-3 device, in which the plasma is heated by a current within it are described. After a brief discussion of the operating principles, it is noted that, due to magnetic-system imperfections, even very small transverse components of the stabilizing magnetic field have a substantial influence on the plasma-pinch behavior within the toroidal chamber. After compensation of the constant component of such a transverse field, the characteristics of the discharge improved appreciably and, in particular, the plasma-pinch conductivity increased. Further studies of the pinch motion clarified the relation between the plasma displacement and oscillations of various electrical parameters. The dependence of the plasma conductivity on the longitudinal field strength was established; with an operating strength of 25 kgauss the minimum estimated conductivity was equal to (1 to 2) $\times 10^{16}$. (OTS)

5310 EFFECTS OF TRANSVERSE MAGNETIC FIELD ON THE TOROIDAL DISCHARGE IN A STRONG LONGITUDINAL MAGNETIC FIELD. B. M. Grigorovich

and V. S. Mukhovatov. At. Energ. (USSR), 17: 177-84 (Sept. 1964). (In Russian)

It was found that, for a given plasma pinch displacement caused by Lorentz force, the oscillation amplitudes of the electric characteristics of the discharge reach a minimum when the plasma conductivity becomes maximum. It was shown that the effect of the transverse component of the magnetic field can be explained using a model of the plasma pinch equilibrated within the conducting mantle. (OTS)

5311 ON THE MECHANISM OF X-RAY AND NEUTRON EMISSION OF POWERFUL PULSE DISCHARGES. M. D. Raizer and V. N. Tsytovich. At. Energ. (USSR), 17: 185-6(Sept. 1964). (In Russian)

A qualitative explanation is presented of some peculiarities of the hard radiation emitted by powerful pulse discharges; the explanation is based on a statistical mechanism of acceleration of particles by plasma waves. (tr-auth)

5312 A PROBE METHOD FOR MEASURING THE SHIFT OF PLASMA PINCH IN CYLINDRICAL AND TOROIDAL CHAMBERS. S. V. Mirnov. At. Energ. (USSR), 17: 209-11(Sept. 1964). (In Russian)

The motion of a plasma pinch in a discharge chamber is interesting for the determination of the characteristics of its macroscopic state as well as for the clarification of the cause of the plasma-wall interaction. If an electric current flows along the pinch, then quantitative information on the motion of the pinch can be obtained, using magnetic probes to measure the current field. Expressions for the horizontal shift in terms of signals in the amplifier output for probe phases differing by π are derived in the cylindrical and toroidal cases. The toroidal apparatus Tokamak-3 was used to determine experimentally the shift of the current pinch. Results for theoretical and experimental dependence of shift on amplifier signals are compared, and the time variation of the shift for different values of magnetic field is presented. (M.J.T.)

5313 MAGNETIC FIELD OF MAGNETIC MIRROR CONFIGURATION INCREASING ALONG THE RADIUS. Yu. M. Martynenko and R. I. Sobolev. At. Energ. (USSR), 17: 211-15(Sept. 1964). (In Russian)

Experimental studies were made previously of plasma containment in an adiabatic trap with magnetic field increasing in both the longitudinal and radial directions. The field is obtained with the combination of the field of a usual trap and the field of a system of linear conductors placed symmetrically around the longitudinal axis of the trap. A simplified study, applicable to the method of magnetic injection, is made of the combined field for the system with four, six, and eight conductors. The results express the basic characteristics of such a magnetic field and permit the parameters of the apparatus to be chosen comparatively simply. The results were used for detailed calculations of the PR-5 apparatus. (M.J.T.)

5314 ATTENUATION OF ELECTROSTATIC OSCILLATION IN A PLASMA. V. Nardi and G. Patergnani. Atti, Ist. Veneto Sci.. Lettere Arti, Classe Sci. Mat. Nat., 121: 309-19(1962-63). (In Italian)

The mechanism of the attenuation of electrostatic oscillations in a plasma based on the phase disordering of electrons (phase mixing picture) is discussed within the framework of the linear theory. A very simple distribution function is used. The inconsistancy of the usual arguments presented against this mechanism is shown. The nature of the plasma frequency obtained by the usual procedures of analytical continuation is detailed in some non-physical cases. (tr-auth)

5315 FLOW IN A PLASMA ACCELERATOR WITH PROGRESSIVE WAVES. Roger Peyret and Thiébaut Moulin (Institut H. Poincare, Paris). Compt. Rend., 259: 1810-13 (Sept. 14, 1964). (In French)

Theoretical studies of flow in a plasma accelerator with progressive waves lead, under certain conditions, to studies of a dynamic flow of gases with electromagnetic forces. A small-perturbation method was utilized to calculate the solution of the first order. It was found that the problem is reduced to the resolution of a single equation with partial derivatives of the first order. (tr-auth)

5316 CHARACTERISTICS OF PLASMA ACCELERATED IN THE PLEIADE MACHINE. Rene Bardet, Terenzio Consoli, and Richard Geller (CEN, Saclay, France). Compt. Rend., 259: 2190-3(Oct. 5, 1964). (In French)

The operation regimes and the characteristics of the plasma beam accelerated in Pleiade are described. (tr-auth)

5317 MODIFIED SNOWPLOW MODEL FOR COAXIAL PLASMA ACCELERATORS. Philip J. Hart (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Appl. Phys., 35: 3425-31(Dec. 1964).

In order to explain previously observed deviations of measured plasma velocities from velocities predicted by computer solutions based on a snowplow model, the experimental and computer data are extended over a much wider range of electrode configurations, capacitor potentials, and gas densities in the shock tube. At low densities the experimental velocity curves fall below the predicted curves because of material evaporated from insulation and electrodes. At high gas densities the experimental velocity curve for the largest center electrode coincides with the predicted curve, but for center electrodes of successively smaller diameter the measured curves lie progressively farther above, but parallel to, those predicted, up to a factor of 5.5 times for the smallest electrode used. These results are explainable in terms of a modified snowplow model postulating an effective annular region adjacent to the center electrode, whose thickness is of the same order as the electrode radius, such that the force due to the magnetic pressure inside this annulus acts on only the gas contained within it to produce the measured velocity. (auth)

5318 PLASMA TEMPERATURE MEASUREMENT FOR THE HOLLOW CATHODE DISCHARGE. A. S. Roberts, Jr., and W. H. Bennett (Univ. of North Carolina, Raleigh). J. Appl. Phys., 35: 3434-6(Dec. 1964).

A retarding potential technique was employed in determining the velocity spread of electrons emerging through an aperture in the anode of a hollow cathode discharge device, which is to serve as an electron source. Estimates of electron temperature for the sample stream emerging into a high-vacuum drift space were inferred by assuming a Maxwellian distribution. Electron temperatures of ~ 1 ev were obtained in this manner, and the assumption of a Maxwellian energy distribution was justified experimentally. Characteristics of the emergent beam are interpreted as being indicative of discharge properties. It was further found that the kinetic energy of the sample stream was consistently several electron-volts greater than that corresponding to the total voltage applied across the arc. (auth)

5319 CHARACTERISTICS OF THE PLASMA RESONANCE PROBE. R. S. Harp and F. W. Crawford (Stanford Univ., Calif.). J. Appl. Phys., 35: 3436-46(Dec. 1964).

The plasma resonance probe was first studied by Takayama and his co-workers in 1960. Since that time several attempts have been made to determine precisely the experimental and theoretical behavior of the resonance. The paper reviews the various contributions made so far, and develops further the explanation advanced in 1963 by Harp. Detailed experiments were carried out to confirm the predictions: that the resonance frequency lies below the local electron plasma frequency; that it is dependent on probe potential and probe size and; that the resonance should be highly damped when probe dimensions are smaller than a few electronic Debye lengths. If the resonance probe is to be of great practical importance, a simplified theoretical model describing its behavior is desirable. The theory of such a model is presented and compared to experimental results. The paper concludes with a discussion of improved methods of applying the resonance probe, and suggests a ringing technique that provides electron density measurements in laboratory discharges in times of the order of a few cycles at the electron plasma frequency. (auth)

5320 VOLTAGE LIMIT OF A THERMALLY IONIZED ONE-DIMENSIONAL GAS DISCHARGE. E. A. Witalis (Aktiebolaget Atomenergi, Studsvik, Nykoping, Sweden). J. Appl. Phys., 35: 3617(Dec. 1964).

It is shown that a limiting voltage for a medium- or high-pressure cold-electrode discharge can be explained and calculated simply as a consequence of the thermal effect of the electrodes on the electric field distribution, i.e., how the strong temperature dependence of the gas resistivity will cause potential drops across the electrode boundary gas layers. (R.E.U.)

5321 A QUANTUM STATISTICAL APPROACH TO LEVEL SHIFT AND LEVEL WIDTH IN A HYDROGENIC PLASMA. Toshio Nakayama (Physics International Co., Berkeley, Calif.) and Hugh DeWitt. J. Quant. Spectry. Radiative Transfer, 4: 623-38(Sept.-Oct. 1964).

The energy levels of a hydrogen atom or hydrogenic ion in a plasma are studied by employing a perturbation expansion of the partition function of the multicomponent plasma, which gives rise to a psuedo-Schroedinger equation. The level shift and width are calculated using the random phase approximation for the dielectric function of the plasma. The results yield a small negative energy shift and a width that is proportional to n^2, where n is the principal quantum number. (auth)

5322 STARK COUPLING OF RADIATION AND PLASMA OSCILLATIONS. Julian Reinheimer (Republic Aviation Crop., Farmingdale, N. Y.). J. Quant. Spectry. Radiative Transfer, 4: 671-8(Sept.-Oct. 1964).

The effects of collective oscillations of electrons on the absorption of radiation by atoms and ions in a plasma are investigated. Longitudinal electron plasma oscillations are examined and their effects on atomic transitions to the second order are considered. The calculations for a single oscillation frequency are analyzed in detail, and it is seen that in addition to the expected Stark broadening of allowed lines there are Stark transitions associated with the forbidden lines. The effects of the frequency distribution of the plasma oscillation are discussed, and the treatment is then extended to include disturbances in the plasma. (auth)

5323 PLASMA-ELECTROMAGNETIC RADIATION INTERACTION. Sylvan Katz (Ford Motor Co., Newport Beach, Calif.). J. Quant. Spectry. Radiative Transfer, 4: 691-703(Sept.-Oct. 1964).

The Liouville equation description of an ionized gas interacting through the medium of the electromagnetic field is considered. A series of approximations and stages of analysis are used to obtain a simplified equation governing the one particle distribution function. The Bogoliubov technique and the Prigogine-Balescu technique are used in the analysis. (C.E.S.)

5324 THE INTENSITY OF AN ELECTRICAL FIELD AT THE SURFACE OF A BODY IN PLASMA. A. V. Gurevich. Kosmich. Issled., 2: 232-45(1964).

The structure of the charged layer at the surface of a body in plasma was investigated. The intensity of the electric field at the surface of the body was determined, and it was shown that field intensity measurements may be used to determine the directional velocity of ion motion in the ionosphere. (D.C.W.)

5325 FORCE ASSOCIATED WITH THE TEMPERATURE GRADIENT ON A SMALL PARTICLE SUSPENDED IN A PLASMA. James R. Brock (National Center for Atmospheric Research, Boulder, Colo.). Nature, 204: 69(Oct. 3, 1964).

The force on a small particle in a plasma having a temperature gradient and imbedded in a magnetic field is calculated, assuming that the particle does not disturb the plasma-particle distribution functions and that the particle is small enough that collective effects are unimportant. It is found that the force on the particle has components parallel and perpendicular to the temperature gradient. (T.F.H.)

5326 ENERGY RADIATED IN SPECTRAL LINES BY AN EQUILIBRIUM PLASMA. PART II. V. S. Vorobyov and G. E. Norman. Opt. Spectry. (USSR) (English Transl.), 17: 96-101(Aug. 1964). Translated from Opt. i Spektroskopiya, 17: 180-88(Aug. 1964).

The method for computing the energy of line radiation, developed for a hydrogen plasma, is extended to be applicable to plasmas of any composition. Specific broadening mechanisms of different lines of complex atoms and ions are taken into consideration, integral expressions for computing the aggregate contribution of weak lines are derived, the multiplet splitting is allowed for, and the mutual overlapping of equivalent line-widths and the effect of continuous spectrum are taken into consideration. As an illustration, the computation method is applied to a nitrogen plasma. Results obtained in this case are sufficiently general and clearly show the roles of individual processes. (auth)

5327 THE BROADENING OF CESIUM LINES IN THE PLASMA OF A DIRECT-CURRENT ARC. V. M. Goldfard and E. V. Ilyina. Opt. Spectry. (USSR) (English Transl.), 17: 159-60(Aug. 1964). Translated from Opt. i Spektroskopiya, 17: 302-4(Aug. 1964).

Measurement of the Stark broadening of spectral lines permits the electron concentration of a plasma to be determined without a precise knowledge of its temperature. The electron concentration in a d-c carbon arc was determined by measuring the broadening of cesium lines. (C.E.S)

5328 RESONANT WAVE-WAVE SCATTERING OF PLASMA OSCILLATIONS. R. E. Aamodt and W. E. Drummond (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 7: 1816-25(Nov. 1964).

The effect of resonant wave–wave scattering of plasma oscillations on the energy spectrum in a turbulent plasma is derived. The problem of a small bump instability in an infinite external magnetic field is discussed as an example. (auth)

5329 NONLINEAR AMBIPOLAR DIFFUSION OF AN ISOTHERMAL PLASMA ACROSS A MAGNETIC FIELD. E. R. Mosburg, Jr., and K.-B. Persson (National Bureau of Standards, Boulder, Colo.). Phys. Fluids, 7: 1829-33(Nov. 1964).

Solutions are presented of the first two moment equations, including nonlinear terms, for the ambipolar diffusion of an isothermal plasma across a magnetic field. The two geometries considered are the plane parallel case and the infinite cylinder with axial symmetry. The Bohm criterion is automatically satisfied by the solutions. It is shown that the singularity in the space derivative of the ambipolar drift velocity at the plasma boundary cannot be removed by an axial magnetic field of any strength. Thus the plasma drift velocity and the plasma density remain monotonic functions of the position coordinate. It is also shown, under the assumptions of this theory, that the ambipolar space charge field is always directed outward and does not reverse direction in this isothermal approximation even for extremely high magnetic fields. One is forced to conclude that a realistic theory of ambipolar diffusion requires the consideration of thermal gradients within the plasma. (auth)

5330 CYLINDRICAL PLASMA COLUMN IN A TRANSVERSE MAGNETIC FIELD. G. Ecker (Universität, Bochum, Ger.) and H. Kanne. Phys. Fluids, 7: 1834-42(Nov. 1964).

The effect of a transverse homogeneous magnetic field B on a stationary cylindrical plasma column is considered. The problem is solved for the collision-dominated and the collision-free case using first-order perturbation theory in B. The potential and density distributions, the temperature, and the Hall reduction factor $\alpha = U_{Hall}/2Rv_d{-}B$ are calculated. The limitations of the theory are considered in detail. (auth)

5331 DENSITY FLUCTUATIONS IN THE ETUDE STELLARATOR. K. Bol (Princeton Univ., N. J.). Phys. Fluids, 7: 1855-63(Nov. 1964). (MATT-224)

Density fluctuations of the ohmically heated plasma of the Étude stellarator can be resolved into azimuthally

propagating waves by means of narrow-band correlation measurements. At frequencies below roughly 100 Gc, propagation velocities are comparable to macroscopic plasma velocities, but increase with frequency and azimuthal mode number. Kink or field degeneracy modes, such as those found on B-1, dominate the spectrum of azimuthal modes at appropriate plasma currents. At frequencies above 100 Gc, the wave propagation velocity tends to become constant at a value nearly an order of magnitude larger than either the ion diamagnetic drift or the mean column rotation velocity, but remains in the same direction. (auth)

5332 COLLISION EFFECTS IN HYDROMAGNETO-IONIC THEORY. Arne A. Wyller (Universitet, Oslo). Phys. Fluids, 7: 1870-71(Nov. 1964).

A hydromagneto-ionic theory is developed that is based on a microscopic treatment, which proceeds via moments of the Boltzmann equation and its associated integral. A fully ionized plasma of electrons and protons is considered, and the momentum and heat-flow equations for the charge species in this plasma are found. These equations are used to determine the electric conductivity tensor. From this tensor are derived the modes of propagation of electromagnetic waves in the plasma. (T.F.H.)

5333 INTERACTION OF A PLASMA STREAM WITH A INHOMOGENEOUS MAGNETIC FIELD. Everet H. Beckner and John R. Banister (Sandia Lab., Albuquerque, N. Mex.). Phys. Fluids, 7: 1871-3(Nov. 1964).

The current density distributions arising from the streaming of a plasma through an inhomogeneous transverse magnetic field are calculated. The theoretical results are compared with experimental shock-tube results using hydrogen gas. (T.F.H.)

5334 MICROWAVE INDEX OF REFRACTION IN A MIRROR FIELD. T. K. Fowler (Oak Ridge National Lab., Tenn.). Phys. Fluids, 7: 1873-4(Nov. 1964). (ORNL-P-16)

The effects of magnetic mirror field curvature on temperature corrections to the formula for the microwave index of refraction of cold plasma are calculated. These effects are found to be small if the microwave frequency is much greater than the electron cyclotron frequency in the plasma. (T.F.H.)

5335 CLASS OF MULTIPLY PERIODIC MAGNETIC FIELD CONFIGURATIONS EXHIBITING HYDROMAGNETIC STABILITY. D. J. BenDaniel and H. Hurwitz, Jr. (General Electric Research Lab., Schenectady, N. Y.). Phys. Fluids, 7: 1874-5(Nov. 1964).

Calculations are presented of a magnetic field structure consisting of an interconnection of two periodic arrays, each of which is unstable alone, but which when connected exhibit a local maximum of flux-tube volume. This local flux-tube volume maximum may make the field configuration under study suitable for plasma containment. Calculations are carried out for a given configuration, and the local maximum is found to exist. (T.F.H.)

5336 HYDROMAGNETIC STABILIZATION OF TOROIDAL SYSTEMS WITHOUT THE USE OF SHEAR IN THE PRESENCE OF ROTATIONAL TRANSFORM. Andrew Lenard (Princeton Univ., N. J.). Phys. Fluids, 7: 1875-7(Nov. 1964). (MATT-279)

Magnetic field configurations having superior hydromagnetic stability properties for plasma containment are investigated, for the case of toroidal configurations having rotational transforms. (T.F.H.)

5337 EQUILIBRIUM AND STABILITY OF A MAGNETIZED PLASMA BOUND BY END PLATES. S. A. Colgate (Univ. of California, Livermore) and S. Yoshikawa. Phys. Fluids, 7: 1877-8(Nov. 1964).

Criteria are studied for equilibrium and stability of plasma cylinders and slabs terminated by dielectric or conducting plates that make angles other than 90° with the plane of the plasma. (T.F.H.)

5338 PLASMA FLOW THROUGH A MAGNETIC DIPOLE FIELD. L. Danielsson and L. Lindberg (Royal Inst. of Tech., Stockholm). Phys. Fluids, 7: 1878-9(Nov. 1964).

A magnetized hydrogen plasma is shot towards a magnetic dipole, in order to simulate the interaction between the solar wind and the geomagnetic field. Three cases are studied: plasma flow parallel to magnetic dipole field; plasma flow antiparallel to field; and zero dipole field. Geomagnetic implications of the results are suggested. (T.F.H.)

5339 INFLUENCE OF THE RAMSAUER EFFECT ON NONEQUILIBRIUM ELECTRON TEMPERATURES. C. H. Kruger and J. R. Viegas (Stanford Univ., Calif.). Phys. Fluids, 7: 1879-81(Nov. 1964).

The departure of electron temperature from ionic temperature in plasma is estimated by means of a balance between energy gained by electrons in the electric field and energy lost by collisions with the heavy particles. A displaced-Maxwellian distribution function is used to assess the importance of the variation of collision cross section with electron energy. For elastic collisions between electrons and rare-gas atoms, the pronounced minimum in the cross section at electron energies on the order of 1 ev is shown to have a significant effect on the variation of collision frequency with electron temperature. (T.F.H.)

5340 MODELS OF COLLISIONLESS SHOCK FRONTS. O. Buneman (Stanford Univ., Calif.). Phys. Fluids, 7: Suppl., S3-8(Nov. 1964).

In the absence of collisions one must attribute the interaction between plasmas of different speeds in a shock front to collective mechanisms of energy and momentum transfer, such as growing plasma oscillations, ion waves, hydromagnetic waves, etc. Numerical one-dimensional plasma models produce evidence that nonlinear wave interaction provides an efficient alternative to collisions for creating shock fronts between two interpenetrating streams of noncolliding particles and, specifically, that the conservation of entropy normally associated with collision-free conditions will, in a practical sense, be violated. (auth)

5341 BOUNDED CURRENT SHEETS. O. K. Mawardi (Case Inst. of Tech., Cleveland). Phys. Fluids, 7: Suppl., S9-16(Nov. 1964).

An adiabatic two-fluid model is used to discuss generalized solutions for the structure of a plane bounded current sheet in a plasma. The current sheet is advancing in a region with no magnetic field. Numerical results for time-independent solutions are given for different values of the ratio of the velocity of the sheet to the Alfvén velocity referred to the magnetic field at a large distance behind the sheet. (auth)

5342 CURRENT SPEED IN A MAGNETIC ANNULAR SHOCK TUBE. James Keck (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 7: Suppl., S16-27(Nov. 1964).

A parametric study of the speeds of the current sheet and center-of-gravity of current in a magnetic annular shock tube has been carried out. The parameters varied include: the drive current; the polarity of the inner electrode; the gas pressure; the nature of the gas; the radius of the inner electrode; and the material of the inner electrode. The most interesting result of the investigation was the observation of limiting speeds for the current sheet and center-of-gravity of current of approximately 8 and 3 cm/μsec, respectively. These speeds were not exceeded even under conditions where the magnetic pressure exceeded the dynamic pressure by a factor of 10. The most probable explanation of the limiting speed is that it is a result of the inertial drag of material ablated from the insulator at the driver end of the shock tube. (auth)

5343 AZIMUTHAL PLASMOID MOTION IN A COAXIAL SOURCE WITH B_z BIAS. David M. Wetstone (United Aircraft Corp., East Hartford, Conn.) and Isaac Greber. Phys. Fluids, 7: Suppl., S35-40(Nov. 1964).

Photographic evidence is presented for the presence of an azimuthal component of the plasmoid motion in a coaxial source of small aspect ratio when operated with an applied B_z field comparable in magnitude to the mean, self-induced B_θ field. The series of displaced images obtained suggests

that the rotation is of the correct sense, and that restrikes of the source rotate in alternate directions with the current reversal in the source every half-wave. Photographs taken without bias field confirm the fact that the plasmoid does not form a continuous torus, and the theoretical consequences of this upon the simple hydromagnetic model are examined. This model is used also to derive an approximate equation of azimuthal motion which predicts an amount of rotation about three times larger than that observed. The amount of rotation does, nevertheless, scale with the bias field strength, as predicted by the model. (auth)

5344 STUDIES OF A COAXIAL PLASMA GUN. A. Dattner and J. Eninger (Royal Inst. of Tech., Stockholm). Phys. Fluids, 7: Suppl., S41-3(Nov. 1964).

An experimental study of the acceleration of plasma between two coaxial electrodes is described. A high current radial discharge is obtained that is highly reproducible and axisymmetric. Particular attention has been given to the study of current distribution in the plasma. It has been found that the current layer has a complicated conical structure exhibiting closed current loops in the plasma. No pressure wave propagating in front of the current layer has been observed. (auth)

5345 STUDIES OF PLASMA EXPELLED FROM A COAXIAL PLASMA GUN. L. Lindberg and C. T. Jacobsen (Royal Inst. of Tech., Stockholm). Phys. Fluids, 7: Suppl., S44-50(Nov. 1964).

An experimental study of the plasma leaving a coaxial gun is described. The plasma shows a conical shape with a central axial pinch. When a radial magnetic field is applied at the muzzle of the gun, magnetized plasma rings are formed. Under certain conditions the central pinch shows a helical instability, resulting in a considerable increase of the poloidal magnetic flux in the plasma rings. Different types of discharges are described, associated with the occurrence of a "short-circuit" in the gun. During the decay of the plasma, magnetoacoustic oscillations are observed. (auth)

5346 EXPERIMENTAL STUDY OF THE PROPAGATION OF AN IONIZING WAVE IN A COAXIAL PLASMA GUN. John M. Wilcox, Evan Pugh, Adam Dattner, and Jan Eninger (Royal Inst. of Tech., Stockholm). Phys. Fluids, 7: Suppl., S51-6(Nov. 1964).

A coaxial plasma gun experiment is described. The gun has an azimuthal bias magnetic field, which is strong compared to the field from the discharge current. The discharge voltage is shown to depend linearly on the bias field, thus defining a velocity that is found to be almost independent of the pressure and the discharge current. This velocity is close to the "critical velocity" which has been found in rotating-plasma experiments. The velocity of the current layer is also measured; it is always smaller than or equal to the critical velocity, and it decreases with increasing pressure and decreasing magnetic field. (auth)

5347 INFERENCE OF PLASMA PARAMETERS FROM MEASUREMENT OF E AND B FIELDS IN A COAXIAL ACCELERATOR. R. Lovberg (General Dynamics Astronautics San Diego, Calif.). Phys. Fluids, 7: Suppl., S57-61(Nov. 1964).

The current layer formed in a coaxial pulsed plasma accelerator has been examined with magnetic and electric field probes. The mappings of E and B indicate that if electrons are assumed to carry the plasma conduction current, the advancing current sheet cannot act as an impermeable piston; rather, it has the character of a strong ionizing shock which imparts some forward momentum to the gas, but does not bring plasma up to its own speed. (auth)

5348 COUPLING BETWEEN PLASMA ELECTRON AND ION OSCILLATIONS. J. M. Jones and K. G. Emeleus (Queen's Univ., Belfast). Phys. Letters, 12: 187-8(Oct. 1, 1964).

Experimental results are presented on low-voltage (17 to 25 v) discharges in mercury vapor, which tend to support the hypothesis that there is a causal relation between electron oscillations and low-frequency fluctuations in beam-plasma systems. (T.F.H.)

5349 ON TURBULENT FLUCTUATIONS IN A TWO-TEMPERATURE PLASMA. I. A. Akhiezer (Inst. of Physics and Tech., Khar'kov). Phys. Letters, 12: 201-2(Oct. 1, 1964).

The fluctuations in a plasma of cold ions and hot electrons, in which the electron velocities are greater than the sound velocity, are studied. The problem of the distribution of turbulent sound waves in the plasma for times long after injection of the supersonic electrons into the plasma is investigated. (T.F.H.)

5350 ELECTROSTATIC STABILITY OF PLASMAS. H. Voelk (Institut für Plasmaphysik GmbH, Garching, Ger.). Phys. Letters, 12: 208-9(Oct. 1, 1964).

The stability problem for a two-component plasma is discussed by considering invariants of the linearized Vlasov equation. For the purely electrostatic case, a large class of unstable solutions is found. (T.F.H.)

5351 RECOMBINATION AND DIFFUSION IN A NEON PLASMA WITH VARIABLE ELECTRON ENERGY. W. Hess (Technische Hochschule, Stuttgart). Phys. Letters, 12: 211-13(Oct. 1, 1964).

A microwave cavity (TE_{011} mode, 10 Gc) is used to measure the recombination and the ambipolar diffusion in a Ne plasma, as a function of the electron energy in the plasma. (T.F.H.)

5352 ADDENDUM ON INERTIAL INTERCHANGE MODES. B. Coppi (Stanford Univ., Calif.). Phys. Letters, 12: 213-14(Oct. 1, 1964).

It is shown that the plasma regime in which the interchange instability is only governed by electron inertia can be treated consistently. A dispersion relation is derived, from which results from collisional or collisionless regimes can be deduced as special cases. (T.F.H.)

5353 NOISE GENERATION AND TRANSMISSION ALONG A PLASMA COLUMN. F. W. Crawford and G. N. Oetzel (Stanford Univ., Calif.). Phys. Letters, 13: 119-20 (Nov. 15, 1964).

It was previously suggested that broad-band noise propagating dispersively along the column would arise from beam-plasma interaction with surface waves, the beam being supplied by the double sheath at a constriction. Experiments on noise propagation and stimulated propagation of n = 0 and 1 modes in a constricted discharge tube placed axially in an S-band waveguide confirmed the hypothesis. (D.C.W.)

5354 OBSERVATIONS ON THE HYBRID ION-ELECTRON RESONANCE. H. Schlueter (Univ. of Texas, Austin). Phys. Letters, 13: 137-8(Nov. 15, 1964).

The hybrid ion-electron resonance at the geometrical mean of the ion and electron cyclotron frequencies in an r-f discharge plasma was investigated. (D.C.W.)

5355 ELECTROSTATIC INSTABILITIES NEAR CYCLOTRON FREQUENCY IN A PLASMA WITH ANISOTROPIC VELOCITY DISTRIBUTION. Laurence S. Hall, Warren Heckrotte, and Terry Kammash (Univ. of California, Livermore). Phys. Rev. Letters, 13: 603-6 (Nov. 23, 1964). (ORNL-P-329)

An approximate mechanical analysis of the coupling of the ion motion to the electrostatic field oscillations was made. The longitudinal modes of oscillation were analyzed in terms of a dispersion relation derived from the linearized Vlasov equation describing an infinite homogeneous magnetized plasma. Several modes of instability were classified and studied. (D.C.W.)

5356 A THEORY OF FLUCTUATIONS IN PLASMAS. B. U. Felderhof (Rijksuniversiteit, Utrecht). Physica, 30: 1771-92(Sept. 1964).

A theory of thermal fluctuations in plasmas is developed based on a probability ensemble for one-particle distribution functions f(r,v). The probability for a specific f(r,v) is

obtained from the canonical ensemble with the aid of the continuum approximation. Subsequently the probability distribution for deviations from the Maxwell-Boltzmann distribution is established. The exponent of this Gaussian distribution is diagonalized by expansion into normal mode solutions of the linearized Vlasov equation. To that purpose van Kampen's normal mode analysis is extended to three-dimensional velocity space. Since the development in time of a fluctuation $f_1(r,v)$ follows from the linearized Vlasov equation a general expression can be given for the joint probability distribution of quantities depending linearly on $f_1(r,v)$ and taken at different points of space and time. By way of example joint probability distributions involving density, potential and electric field, current density, and pressure are calculated. The influence of an external force on the fluctuations is investigated. Finally the non-equilibrium case is discussed. (auth)

5357 CONVERGENT CORRELATION FUNCTION FOR A TWO-COMPONENT PLASMA. G. L. Lamb, Jr. (United Aircraft Corp. Research Labs., East Hartford, Conn.). Phys. Rev. Letters, 13: 683-4(Dec. 7, 1964).

A quantum-mechanical analysis of the short-range part of the electron-ion correlation function is outlined. The starting point of the calculation is a two-particle Wigner distribution function. The corresponding radial distribution function is then written in the form given by Goldberger and Adams. It is found that the finite value of Planck's constant provides a natural short-range cutoff for the divergence appearing in the classical calculation. The distance at which this effect takes place is on the order of $(l\lambda^2)^{1/3}$, where l is the Landau length and λ is the thermal de Broglie wavelength. (C.E.S.)

5358 ESTABLISHMENT OF THE ELECTRIC CURRENT IN AN IONIZED GAS. A. K. Musin. Teplofiz. Vysokikh Temp., 2: 142-55(1964).

An approximate analysis of the establishment of the electric current and the near-electrode space-charge sheaths in a non-self-maintaining discharge plasma is presented, and the main transient time constants are determined. The original theory of J. J. Thomson is obtained as a particular limiting case. The transients arising when plasma flows into the space between the discharge electrodes are divided into three distinct stages: an initial period in which the electric field is established in the plasma gap and the current density remains approximately proportional to the electric field intensity; an intermediate period in which the electrode-potential drop and space-charge sheaths are established; and a steady-current period in which the electric current density in the electrodes remains constant and is determined by the ionization rate. The plasma conductivity, the charged-particle concentration in the plasma gap, and the ionization rate in the plasma can be determined from the voltage-current characteristics during these three periods, respectively. The boundaries between these periods depend on the charged-particle concentration, the ionization rate, the positive-ion mobility, and the relaxation times of the electric fields in the various regions in the gap. (ATD)

5359 ANALYSIS OF THE HALL EFFECT IN A MOVING PLASMA. A. V. Gubarev and V. I. Kovbasyuk. Teplofiz. Vysokikh Temp., 2: 156-9(1964).

By representing the electric field vector and the current density in the plasma as complex numbers, so that the power absorbed from the electric external field or given up to the field can be plotted as a family of circles in the complex plane, a graphic method is developed for determining the energy balance of a plasma moving in crossed electric and magnetic fields. The cases considered are zero longitudinal field, zero transverse field, zero longitudinal current, and electric field equipotentials making a fixed angle with the plasma velocity vector. It is pointed out that the graphical technique makes it very easy to determine the optimum plasma flow conditions (when the maximum energy transfer occurs at minimum dissipation). (ATD)

5360 ON THE STABILITY OF A COMPRESSIBLE PLASMA COLUMN. Bing-ren Shi. Wu Li Hsueh Pao, 20: 785-95(Aug. 1964). (In Chinese)

An expression for the compressibility $\nabla \cdot \xi$ of a plasma is obtained from the linearized magnetohydrodynamic equations of motion. This compressibility term, in general, consists of two different parts: the first connects with the longitudinal initial motion of the plasma, and the second with the uniform motion (dilatation and contraction) of the plasma-carrying magnetic tubes. For a plasma column, several cases are considered which permit simplification to some extent of the solution of the equation of motion including the compressibility term. With the aid of these results, a dispersion relation describing the motion of the plasma column with uniform current distribution is derived and analyzed. (auth)

5361 MATERIAL FUNCTIONS OF ARC PLASMA FROM CHARACTERISTIC MEASUREMENTS. Alfonso Monterde-Garcia (Technische Hochschule, Munich). Z. Physik, 181: 317-30(1964). (In German)

A calculation procedure is described which permits evaluation of the material functions (electrical conductivity σ and radiation density u as a function of the heat flux potential S) from the measured arc characteristics E(I) and U(I) (field strength and radiated power per unit arc length as a function of current strength), using the additional relation of energy balance and the current transport equation. The procedure is applied to N_2 and Ar. If the radial temperature distribution is known, the temperature dependence of σ, u, S and κ (thermal conductivity) may also be determined. The material functions of the N_2 plasma are evaluated from available measurements. (auth)

5362 EXPERIMENTS ON COLLISIONLESS SHOCK WAVES IN PLASMA. A. M. Iskoldskii, R. Kh. Kurtmullaev, Yu. E. Nesterikhin, and A. G. Ponomarenko (Inst. of Nuclear Physics, Academy of Sciences, Siberian SSR). Zh. Eksperim. i Teor. Fiz., 47: 774-6(Aug. 1964). (In Russian)

Preliminary results are presented from a study of shock-wave propagation in low density plasma ($n < 10^{14}$ cm^{-3}), in which the path length in respect to charge exchange is substantially greater than the path of the shock wave. The apparatus, consisting of a glass tube with axial magnetic field, is described. Typical oscillograms of the flow of the shock contour and the change of magnetic field at the shock front and a scanning in time of the shock luminescence in He plasma are given. Additional phenomena accompanying the convergence of the shock wave on the chamber axis were recorded. (M.J.T.)

5363 CYCLOTRON INSTABILITY OF A PLASMA INVOLVING COLLISIONS. O. P. Pogutse. Zh. Eksperim. i Teor. Fiz., 47: 941-51(Sept. 1964). (In Russian)

Cyclotron instability of an inhomogeneous plasma is considered by taking into account collisions. Collisions are taken into account by introducing into the kinetic equation a model collision term in the Bhatnagar–Gross–Krook form. The effect of collisions on the increment and stability boundary is analyzed. For oscillations with $k_z = 0$ inclusion of collisions leads to an expansion of the instability region if in a non-collision plasma the increment of oscillations with $k_z = 0$ was of a resonance nature and did not vanish only for a certain value of $k_\perp$, in the case under consideration there may be a build-up of oscillations in a broad range of $k_\perp$ (although the increment might be small). With further increase of the collision frequency ($\nu_{ei}/\omega_{Bi} > 1$) the instability region decreases, the increment drops and the oscillations become stabilized. If collisions are frequent ($\nu_{ei}/\omega_{Bi} \gg 1$) the increments for oscillations with $k_z = 0$ become equal and the range of wave vectors k_z in which oscillation buildup for $k_z \neq 0$ is possible becomes broader ($\Delta k_z \sim \nu_{ei}/\omega_{Ti}$). The possibility of cyclotron oscillation build-up in a weakly ionized plasma is considered. The weakly ionized plasma may be unstable for certain values of the parameters. (auth)

5364 THEORY OF NONLINEAR MOTIONS IN A NONEQUILIBRIUM PLASMA. I. A. Akhiezer (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 952-7(Sept. 1964). (In Russian)

Low frequency one-dimensional motions of finite amplitude in a nonequilibrium plasma consisting of hot electrons

and cold ions are considered. It is demonstrated that such motions can be described by means of a peculiar type of hydrodynamics with an infinite number of hydrodynamic quantities. The hydrodynamic equations are applied for investigating simple waves in a nonequilibrium plasma. The direction of variation of the quantities characterizing the plasma (including the electron distribution function) in a simple wave is determined. It is shown that depending on the initial distribution of the electrons with respect to velocity the following four cases are possible: discontinuities (or multi-current flows) arise in compression regions, the automodel waves being rarefication waves; discontinuities (or multi-current flows) arise in rarefication regions and the automodel waves are compression waves; the profile of a finite amplitude wave does not become distorted during propagation of the wave and no discontinuities appear; discontinuities (or multi-current flows) may appear in compression as well as in rarefication regions but the density at the discontinuity point cannot exceed (or cannot be smaller than) a certain critical value. Uniform expansion or compression of a plasma consisting of hot electrons and cold ion is also considered. (auth)

5365 EXPERIMENTAL INVESTIGATION OF AN INDUCTION DISCHARGE. B. M. Dymshits and Ya. P. Koretskii. Zh. Tekhn. Fiz., 34: 1677-82(Sept. 1964). (In Russian)

Data are given on stationary high-frequency induction discharges in inert gases. Under given conditions (frequencies from 290 to 3300 kc, 200 to 1500 mm Hg pressure, and discharge from 2000 to 10000 l/hr in argon) a relation was found between the diameter of the plasma pinch and the generator frequency. (R.V.J.)

5366 EXPERIMENTAL INVESTIGATION OF AN INDUCTION DISCHARGE. I. M. Bortnik (Lenin Power Engineering Inst., Moscow). Zh. Tekhn. Fiz., 34: 1683-7(Sept. 1964). (In Russian)

Experimental studies were made of positive corona discharge in a coaxial electrode system. The principal characteristics of the discharge were studied, and peculiarities are indicated. The relation of discharge ignition to the similitude law of coaxial systems was analyzed. (tr-auth)

5367 ON THE THEORY OF CYCLOTRON RADIATION OF IONS IN A PLASMA. V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 34: 1701-5(Sept. 1964). (In Russian)

The intensity of cyclotron emission increased with particle velocity near the wave phase velocities c/n. It was noted that electromagnetic waves with large diffraction indices (n) propagate in plasma in a magnetic field with nonrelativistic particles exciting high gyrofrequency harmonics. A frequency corresponding to plasma waves for which n reaches c/v_{T_e} (v_{T_e} is electron thermal velocities) was found along with a low-frequency wave region in which $n = c/v_A = A \gg 1$ (v_A is Alfven velocity). The loss of ion energy in plasma wave radiation may exceed the losses in low-frequency wave radiation. An explicit analytical expression was obtained for radiation of various harmonics. (R.V.J.)

5368 HIGH FREQUENCY QUASIPOTENTIAL FOR CHARGED PARTICLES IN A MAGNETIC FIELD. K. S. Golovanivskii and A. A. Kuzovnikov (Moscow State Univ.). Zh. Tekhn. Fiz., 34: 1714-17(Sept. 1964). (In Russian)

A formula was developed for the charged particle high-frequency quasipotential in a homogeneous magnetic field with particle collisions; special expressions were included for cases without collisions or magnetic fields, with collisions but without magnetic fields, and with magnetic fields but without collisions. (R.V.J.)

5369 ABOUT TEMPERATURE OF IONS AND ELECTRONS OF PLASMA IN ALPHA. B. V. Galaktionov, K. A. Dolmatova, and M. M. Larionov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1718-20(Sept. 1964). (In Russian)

The relation between ion and electron temperatures was studied in order to determine the processes leading to plasma heating and energy exchange between plasma components. Measurements indicated that ion temperatures are 1.5 to 2 times the electron temperatures. The relative error in T_i and T_e was 15 to 20%. The difference in the temperatures was a result of ion heating by fluctuating electric fields and energy exchange during collisions. (R.V.J.)

5370 ELECTRONIC CYCLOTRON RESONANCE IN A MAGNETIC TRAP. I. DISTRIBUTION FUNCTION. A. D. Piliya and V. Ya. Frenkel (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1752-63(Oct. 1964). (In Russian)

A mathematical analysis was made of electron distributions in magnetic traps. A high-frequency resonance field was used for electron heating. Distribution functions were obtained for a constant electron density and for density increasing with time. (tr-auth)

5371 ELECTRONIC CYCLOTRON RESONANCE IN A MAGNETIC TRAP. II. PENETRATION OF HIGH FREQUENCY FIELD INTO THE PLASMA. A. D. Piliya and V. Ya. Frenkel (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1764-8(Oct. 1964). (In Russian)

An attempt was made to find a function for high-frequency field penetration into plasma in a magnetic trap. The ratio between the high-frequency field on the resonance surface and the amplitude of the incident wave at a distance from the plasma (or the coefficient of reflection from the plasma) was calculated. In order to solve the problem the equations for high-frequency current in the plasma were substituted in the Maxwell equation and solved according to the corresponding boundary conditions, assuming all magnitudes to be functions of only one cylindrical coordinate (z) common to the system. (R.V.J.)

5372 MAGNETIC FIELD OF CURRENTS FLOWING ON THE SURFACE OF A TORUS. N. I. Doinikov. Zh. Tekhn. Fiz., 34: 1769-79(Oct. 1964). (In Russian)

Expressions for vector potential components in toroidal configurations were found for meridian and latitudinal surface currents. Approximation formulas for determining the field in the plane $z = 0$ were based on an expansion of the Taylor series in the circumference $\alpha = \infty$; the series coefficients were written as a closed expression. (tr-auth)

5373 THE INFLUENCE OF TOROID AND CRIMPING ON THE MAGNETIC SURFACE OF A DOUBLE-ENTRANCE HELICAL FIELD. G. S. Voronov and A. P. Popryadukhin. Zh. Tekhn. Fiz., 34: 1780-5(Oct. 1964). (In Russian)

Disturbances of helical symmetry and distortion of power lines in stellerators interfere with particle containment in magnetic traps and closed circuit systems. Toroidal and crimping effects in a double-entrance helical field were well integrated with path length to secure power lines for $n \sim 10^3$ circuits. (R.V.J.)

5374 EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF DISTURBANCES ON A HELICAL MAGNETIC FIELD. G. S. Voronova and A. P. Popryadukhin. Zh. Tekhn. Fiz., 34: 1786-9(Oct. 1964). (In Russian)

Measurements using a modeling method showed that disturbances of the dipole type and disturbances caused by the input of a helical winding without compensation were not drastic in the case of nonresonance. In such a case the magnitude of the shift (Δx), evaluated by the formula $\Delta x \approx (\tilde{H}_\perp/H_0)\, l$ (where $\tilde{H}_\perp$ is the transverse component of the magnetic field), is proportional to the disturbed effective length l. Thus, local disturbances are considerably less damaging than like homogeneous transverse fields, which cause considerable shifts at $\tilde{H}_\perp/H_0 \approx 0.1\%$. (R.V.J.)

5375 THE RADIATION FROM A PLASMA JET. Yu. V. Skvortsov, V. S. Komelkov, and V. N. Tereshchenko. Zh. Tekhn. Fiz., 34: 1790-7(Oct. 1964). (In Russian)

Plasma jets with "gushing" pinch are formed in coaxial accelerators with short electrodes. An analysis was made of the spectra of various portions of such jets under various discharge conditions. An installation with a power of 10 to 30 kev hydrogen pressure of 0.1 to 1 mm Hg, capacitance of

130 μf, oscillation periods of 22 μsec, and discharge amplitudes of 200 to 550 ka was used. (R.V.J.)

5376 ON THE AMPLIFICATION OF ION CYCLOTRON WAVES BY MEANS OF AN ELECTRON BEAM. D. G. Lominadze. Zh. Tekhn. Fiz., 34: 1803-6(Oct. 1964). (In Russian)

Amplification of ion cyclotron waves by electron beams and conditions for an efficient transmission of electron beam energy to ions were investigated. Amplification of ion cyclotron oscillations is possible only when the increment of excitation for longitudinal oscillations does not exceed the ion cyclotron frequency. The increments of wave excitation were determined for weak and strong magnetic fields. (R.V.J.)

5377 ON THE WAVE CONVERSION IN A MAGNETOACTIVE PLASMA. N. L. Tsintsadze. Zh. Tekhn. Fiz., 34: 1807-16(Oct. 1964). (In Russian)

Wave conversion in electron-ion plasma in a constant homogeneous magnetic field was studied, taking into account weak nonlinearity. Expressions were obtained for amplitudes of nonlinear transverse and longitudinal waves. In order to avoid complexity in the general expressions, an analysis was made of wave propagation along the constant homogeneous field at small angles and perpendicular to it. It is shown that transverse waves produce nonlinear longitudinal fields. Radiation of plasma oscillations from electromagnetic fields occurred with the presence of axial anisotropy. The radiation is weak but it can leave the plasma easily. The emitted wave frequency depends on the type of interaction. A new resonance was found, and the theory for nonlinear electromagnetic field thermal fluctuations in electron-ion plasma was generalized. Expressions were obtained for emitted field Fourier component and spectral density correlation. (R.V.J.)

5378 ON THE INTERACTION OF WAVES IN A CONFINED PLASMA. N. P. Giorgadze, D. G. Lominadze, and V. G. Makhankov. Zh. Tekhn. Fiz., 34: 1817-22(Oct. 1964). (In Russian)

Interactions of waves in cylindrical waveguides were investigated. It was found that, for small nonlinearities and in the absence of oscillations, the H-wave density is linear and E waves can be generated by interactions of either H or E waves. In linear approximation the presence of a Langmuir frequency results in the generation of nonlinear H waves. (tr-auth)

5379 EXCITATION OF LOW-FREQUENCY LONGITUDINAL OSCILLATIONS IN PLASMA IN MAGNETIC FIELD. D. G. Lominadze and K. N. Stepanov. Zh. Tekhn. Fiz., 34: 1823-34(Oct. 1964). (In Russian)

Excitation of low-frequency longitudinal oscillations by electron drift, in relation to ions, was studied under conditions in which the drift was induced by an external electric field or by a low-density particle beam passing through the plasma along an external magnetic field. (R.V.J.)

5380 THE INFLUENCE OF PARTICLE DRIFT ON THE PROPAGATION OF AN ORDINARY WAVE IN A NONHOMOGENEOUS PLASMA. D. P. Kostomarov (Moscow State Univ.). Zh. Tekhn. Fiz., 34: 1835-42(Oct. 1964). (In Russian)

Studies of plane waves propagating in a nonhomogeneous plasma in a transverse direction showed that particle drift caused by nonhomogeneity of the magnetic field may induce either oscillations or oscillation damping. Increments were calculated. (tr-auth)

5381 INVESTIGATION OF THE THERMAL RADIATION OF A HOT PLASMA IN THE 3 TO 12 mm RANGE. M. M. Larionov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 1843-51(Oct. 1964). (In Russian)

Problems arising during plasma parameter determination from thermal emission in the millimeter wave range were analyzed. Results are given from thermal emission investigations at the alpha installation using a wide range of receivers. (tr-auth)

5382 SOME CHARACTERISTICS OF AN ELECTRODELESS RING DISCHARGE. A. D. Andreev and Yu. N. Lobanov. Zh. Tekhn. Fiz., 34: 1863-6(Oct. 1964). (In Russian)

The behavior of electrodeless ring discharge in air or nitrogen excited by a high-frequency coiled-wire field was investigated. The obtained pictures indicate a constriction of the discharge toward the axis of the cylindrical tube followed by an expansion as the gas pressure changed. (tr-auth)

5383 ON THE CHOICE OF OPTIMAL PARAMETERS OF A PLASMA ACCELERATOR. L. V. Dubovoii and Yu. A. Berezin. Zh. Tekhn. Fiz., 34: 1867-70(Oct. 1964). (In Russian)

Factors contributing to a more effective performance of a rail-type plasma accelerator are evaluated. The data indicated that the parameters of existing accelerators fall short of theoretical requirements for efficient performance. (R.V.J.)

5384 ON RADIAL PROPERTIES AND CONTRACTION OF A POSITIVE COLUMN IN INERT GASES AT MEAN PRESSURES. Yu. M. Kazan and P. I. Lyagushchenko (Leningrad State Univ.). Zh. Tekhn. Fiz., 34: 1873-8(Oct. 1964). (In Russian)

Radial properties of a positive column are analyzed using a model of excitation and ionization processes in inert gases as mean pressures. The phenomenon of positive column contraction is described. (tr-auth)

5385 VOPROSY TEORII PLAZMY. VYPUSK 4. (Problems in Plasma Theory. Issue 4). M. A. Leontovich, ed. Moscow, Atomizdat, 1964. 344p.

The basic hydrodynamics of strongly rarefied plasma and the theory of hydrodynamic flow of ideally conducting liquid are discussed. The theory of instability of plasma particle motion is extensively reviewed. 216 references. (R.V.J.)

5386 UPRAVLYAEMYE TERMOYADERNYE REAKTSII. (Controlled Thermonuclear Reactions). L. A. Artsimovich. Moscow, State Publishing House of Physico-Math. Literature, 1963. 496p.

A review is given of plasma physics, preparation of super-high temperatures, and thermonuclear reactions. Problems and perspectives of controlled thermonuclear reactions are discussed. 156 references. (R.V.J.)

5387 ELECTRICAL PLASMA-JET APPARATUS AND METHOD INCORPORATING MULTIPLE ELECTRODES. Gabriel M. Giannini and Adriano C. Ducati (Giannini Scientific Corp.). U. S. Patent 3,149,222. Sept. 15, 1964. Filed Aug. 21, 1962.

An apparatus and method making use of more than two electrodes for achieving extremely high plasma temperatures and for velocities, and for performing useful functions including cutting, welding, and spraying, are described. A high-current arc is maintained between a workpiece and the nozzle electrode of a plasma torch. The first and second electrodes are mounted in spaced and insulated relation. A third electrode is mounted between the first and second electrodes and insulated from them. An orifice is provided in the third electrode through which plasma may pass in traveling between the first and second electrodes. Means of generating high-current electric arcs and of constricting one of the electric arcs to a cross-sectional area substantially smaller than it would normally occupy are provided. This constriction means includes a means of rapidly circulating a fluid vertically around at least one arc to constrict it to the vortex in the circulating fluid. (M.C.G.)

Shielding

5388 (DESY-64/11) DIE ABSCHIRMUNG VON 4.8-Gev-BREMSSTRAHLUNG DURCH SCHWERBETON. (The

Shielding of 4.8-Gev Bremsstrahlung with Heavy Concrete). G. Bathow, E. Freytag, and K. Tesch (Deutsches Elektronen-Synchrotron, Hamburg). Aug. 1964. 20p. Dep. (mn).

Bremsstrahlung produced by 4.8-Bev electrons impinges upon a quantameter; the emerging radiations and their attenuation in heavy concrete are measured. The following instruments are used: tissue-equivalent ionization chamber, argon-filled ionization chamber (Jordan chamber), neutron dosimeter, and several activation foils for measuring the neutron flux. Results are given for the neutron flux and dose rates of some radiation components behind concrete shielding up to 160 cm and at angles from 0 to 125°, for the attenuation coefficients of the radiation components, and for the number of giant-resonance neutrons produced per quantum. (auth)

5389 (UCRL-11331) RADIATION FIELD INSIDE A THICK CONCRETE SHIELD FOR 6.2-Bev INCIDENT PROTONS. Alan R. Smith, Joseph B. McCaslin, and Michael A. Pick (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 18, 1964. Contract W-7405-eng-48. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

An investigation was conducted of some characteristics of the radiation field inside a massive shield of ordinary concrete when such a structure is bombarded by a sharply focused beam of 6.2-Bev protons. The external proton beam from the Berkeley Bevatron is directed onto one face of the shield array. This array permits study of the radiation field to depths of 24 ft along the beam axis, and laterally to distances of 10 ft off-axis. Attenuation measurements obtained during the experiment are presented. Complete sets of lateral activity profiles were obtained with gold foils (thermal-neutron flux), aluminum discs (flux greater than 7 Mev), and carbon scintillators (flux greater than 20 Mev). Several transformations of the data are shown in an effort to clarify properties of the radiation field as viewed by these three detectors. Such information should be of immediate value to shield design at particle accelerators in the multi-Bev energy range; therefore the attenuation measurements are presented now, although data processing and analysis from other aspects of the experiment are not complete. These aspects include measurement of fast-neutron flux, fast-neutron spectra, and induced activation of several important accelerator construction materials. (auth)

5390 SCATTERING OF UNCOLLIMATED COBALT 60 GAMMA RADIATION BY CONCRETE AND LEAD BARRIERS. W. H. Henry and C. Garrett (National Research Council, Ottawa). Acta Radiol. Therapy, Phys., Biol. (N.S.), 2: 353-64(Oct. 1964).

The percentage contribution to exposure rate, in roentgens per unit time, due to ^{60}Co gamma radiation scattered by concrete and lead barriers was measured for a point isotropic source and an ionization chamber in lines normal and parallel to the barrier surface. (auth)

5391 THE DEPENDENCE OF THE ^{60}Co γ-RADIATION LINEAR ATTENUATION COEFFICIENT ON THE TEMPERATURE OF THE METAL-ABSORBER. V. I. Kutovoi and V. I. Stetsenko. At. Energ. (USSR), 17: 224-4(Sept. 1964). (In Russian)

Values of the attenuation coefficient of ^{60}Co γ radiation were determined experimentally for effective metal-absorber thickness producing the minimum measurement error ($\mu d \approx 1.5$). The temperature dependence of μ was measured on a special device which maintains constant optimum thickness of absorber during the heating process. Results are given for Al, Bi, Cd, Au, Pb, Li, Mg, K, Ag, Na, Sn, and Zn. (M.J.T.)

5392 REACTOR NEUTRON SHIELD WITHOUT HYDROGEN. Boris Rafailovič Bergelson (Inst. of Theoretical and Experimental Physics, Moscow). Jaderna Energie, 10: 281-7(Aug. 1964). (In Czech)

The biological neutron shield without hydrogen is treated. The analysis of conception, choice of shielding materials, and shield optimization with a space and energy distribution of neutrons in a shield without hydrogen is described. Structures containing boral, graphite, and iron in technical and biological reactor shields were studied. (auth)

5393 RESIDUAL RADIATION STUDIES FOR MESON FACTORIES. C. B. Fulmer (Oak Ridge National Lab., Tenn.). K. S. Toth, and M. Barbier. Nucl. Instr. Methods, 31: 45-54(Dec. 1, 1964).

The reliability of estimates of residual radiation levels to be encountered in high intensity meson producing accelerators was tested by comparing calculated levels with experimental results. A computer calculation was used for determining the gamma dose rates near slabs of material after irradiation by a beam of fast protons incident normal to the slab surface. Spallation cross sections available from published sources were used in the computation. Dose rates were calculated for each spallation product and the combined dose rate was determined by summing the contributions of all spallation products. Calculations were made as a function of cooling time to determine gross dose rate decay curves for the induced γ radiation in various materials. Samples of material were exposed to the CERN Synchro-Cyclotron 600-Mev proton beam and decay curves were obtained for the gross activities induced in these materials. The calculated and experimental decay curves agree within a factor of two or three. It is demonstrated that the results of the computer calculation can be used to determine residual radiation resulting from irradiation of materials by distributed fluxes of fast particles. Examples of practical application of the calculation are discussed. Conceptual designs of thick target shields and beam stops are presented. (auth)

REACTOR TECHNOLOGY

General

5394 (NAA-SR-9425) A TRANSIENT MULTI-CHANNEL TWO-PHASE HYDRAULIC CODE. L. R. Steele and R. F. Berland (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-8. 61p. Dep.; $3.00(cy), 2(mn) OTS.

A description of a computer program that calculates both steady-state and transient distribution of flow in a reactor core is presented in this report. Results are compared to experimental data for the transient characteristics and to another program for the steady-state distribution of flow. The program may handle a single channel or multiple channels with crossflow under either natural or forced circulation. (auth)

5395 (NAA-SR-Memo-10290) AN EXAMPLE OF THE APPLICATION OF A DIGITAL COMPUTER PROGRAM FOR REACTOR SITING HAZARD EVALUATION. R. A. Blaine and A. A. Jarrett (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 17, 1964. Contract AT-11-1-GEN-8. 68p. Dep. (mn); $3.00(cy), 2(mn) OTS.

The advantages of utilizing a digital computer program for reactor siting hazard evaluation are shown. By way of example, the computer program AISITE II, developed for application to any reactor and any siting criteria, was used to calculate environmental radiation doses and USAEC Reactor Siting Criteria, 10 CFR 100, resulting from an assumed accident in a hypothetical sodium-cooled reactor. Non-volatile species (plutonium, radiosodium, and solid fission products) as well as the halogens and the rare gases were assumed available for release. Graphical outputs of typical parametric surveys were made to display dose versus distance by specific organ or specified critical distances versus variable parameter. (auth)

5396 (ORNL-3605(Vol.1)(p.1-2)) THE MPRE—A BOILING POTASSIUM REACTOR SYSTEM. Arthur P. Fraas (Oak Ridge National Lab., Tenn.).

The advantages of a single-fluid system generally and of potassium specifically in a nuclear space power plant are pointed out. Potassium can serve as a lubricant as well as a reactor coolant and a thermodynamic-cycle working fluid. The problem of boiling flow stability and the analytical approach taken to solve the problem are discussed very briefly. (D.L.C.)

5397 (TID-21056) NOL REACTOR-VESSEL CONTAINMENT PROGRAM. Progress Report, July 1, 1962–October 31, 1963. (Naval Ordnance Lab., White Oak, Silver Spring, Md.). 84p. (NOL-285). Dep.(mn); $3.00(cy), 2(mn) OTS.

Work in a program employing explosives and propellants to simulate nuclear excursions in idealized model reactor vessels is reported. Included in the program are studies of vessel response in the plastic domain with material, shape, and constraint as parameters for use in formulation of a general law of reactor vessel excursion containment. The information and data to be used in designs for safe containment are presented in a series of bimonthly reports covering the period. (J.R.D.)

5398 METEOROLOGICAL FACTORS IN REACTOR INSTALLATIONS. Walter Schroeck-Vietor (Kernforschungsanlage, Julich, Ger.). At. Strom, 10: 73-7(Sept. 1964). (In German)

A summary of previous British, German, and French reports of the International Standards Organization is presented. Meteorological problems preceding site selection, during planning and construction of the installation, and during the operation of the reactor are reviewed. The principles for statistical evaluation and stability of the atmosphere are summarized. (J.S.R.)

5399 ON THE DETECTION OF CLADDING FAILURE IN A REACTOR BY MEASURING THE COOLING WATER ACTIVITY. E. Ionescu, Z. Alexan, and I. Purica (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 373-8(1964).

The necessity of a periodic analysis of the water of the primary reactor circuit in order to obtain information on the occurrence of cladding failure was demonstrated. A series of experiments was performed with coolant containing the usual background activity produced by corrosion products; the effects of unirradiated uranyl azotate and uranyl azotate irradiated in the reactor to various exposures on the gamma spectrum of water from the reactor were determined. (D.C.W.)

5400 IMPROVEMENTS IN OR RELATING TO LIQUID MODERATED REACTORS. Clifford Graham Campbell, Raymond Kenneth Hilton, Kenneth Barker, and Richard Norman Hansford (to United Kingdom Atomic Energy Authority). British Patent 968,889. Sept. 2, 1964. Filed June 28, 1961.

A liquid-moderated reactor is designed for emergency control by means of moderator level variations. The reactor core is supported in a tank of moderator, and a baffle is mounted below the core for retaining a volume of pressure gas to support the moderator at a given level above the core. Two conduits communicating with the baffle are provided, one for releasing the pressure gas and the other for indicating the position of the moderator surface within the baffle. When it is desired to reduce the reactivity, the first conduit is opened to vent the pressure gas, resulting in a drop of the moderator level in the tank. (D.L.C.)

5401 UTILIZATION OF ENERGY OF FISSIONABLE ELEMENTS IN CHEMICAL CONVERSIONS. (to Socony Mobil Oil Co., Inc.). British Patent 970,864. Sept. 23, 1964. Priority Oct. 29, 1959, United States.

A chemonuclear reactor system is described. In one method of operation, microporous alumina particles containing 10 wt. % U (40% enriched) are the core material through which CH_4 gas is passed upward at 10 psig. Graphite spheres may be added if further moderation of neutrons is needed. The product at the top of the reactor contains H_2, a mixture of olefins and paraffins C_2 to C_3, and CH_4. Other methods of operation are described. (T.R.H.)

5402 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR APPLYING AND SECURING AN ELONGATE MEMBER WITHIN A CIRCUMFERENTIAL GROOVE. John Harold Weaver, Geoffrey Peters Hopkins, and Almond Tinkler (to United Kingdom Atomic Energy Authority). British Patent 974,283. Nov. 4, 1964. Filed June 13, 1961.

A device is described which applies a U foil strip to a groove in a fuel element end cap. The foil serves to release fission products to the coolant monitoring system if the element is breached. The strip is guided into the groove, the groove rotated, and then peened to secure the strip in the groove. (T.R.H.)

Auxiliaries and Components

5403 (EURAEC-1174) DEVELOPMENT PROGRAM ON THE APPLICATION OF STEAM–WATER SPRAY TO REACTOR COOLING. CAN-3 Quarterly Progress Report No. 10, April 1–June 30, 1964. (Centro Informazioni Studi Esperienze, Milan). July 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 056-62-1-RDI. 9p. (CISE-R-127). Dep.(mn); $1.00(cy), 1(mn) OTS.

Heat transfer experiments during the period in the large-scale Genova loop were devoted entirely to the study of cluster geometries. Critical heat flux and pressure

drop measurement were performed on two different cluster elements having seven heated rods. The crisis was found to set on one of the outer rods, without particular preference for any of them. As a whole, 140 points were obtained at the crisis; the trend of the results was regular and confirmed the observations made on tubes and annular test elements. In a particular case the temperature profile along the axis of one external rod was taken, in conditions near crisis. The work concerning large scale experiments on heat transfer and hydrodynamics under the CAN-3 program was completed. With the exception of two weeks, in which the in-pile loop was working for water chemistry and radiolysis experiments, the reactor was out of operation for the whole quarter. Consequently it was decided to ask for a two-month extension of the CAN-3 contract in order to permit the completion of the water chemistry experiments. In the meantime about 600 hr of out-of-pile corrosion tests were performed. Analyses for H_2 content are in progress in radioactive corrosion samples of Zircaloy-2. Static corrosion tests were suspended because of an accident involving the autoclave temperature regulating system; after repairs two new tests were initiated and are now under way. Analyses of corrosion products deposited on filters and resins were completed. (auth)

5404 (LFEN-18) ÉTUDE THÉORIQUE D'UN SYSTÈME DE PILOTAGE AUTOMATIQUE PAR "TOUT OU RIEN" POUR UN RÉACTEUR NUCLEAIRE. (Theoretical Study of a "Go-No Go" Automatic Control System for a Nuclear Reactor). J. Menezes and P. Jover (Portugal. Junta de Energia Nuclear. Laboratório de Física e Engenharia Nucleares, Sacavém). Apr. 18, 1964. 26p. Dep. (mn).

Simultaneously Published as CEA-R-2547.

The automatic control system ddsigned for a high-flux reactor is of the "constant speed-dead zone" type, in which the control rod is run at normal speed in the required direction when the error signal overrides a preset level. The study of the closed-loop absolute stability was carried out with the describing function method. An analog computer study yielded the optimal values of the setting parameters (relay hysteresis, motor response time), which lead to a minimization of the control-steps frequency when the reactivity varies slowly with the xenon poisoning. (auth)

5405 (WCAP-3374-2) SUPERCRITICAL TECHNOLOGY PROGRAM. Quarterly Progress Report No. 2, July–September 1964. J. F. Patterson and W. S. Boyd, comps. and eds. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Contract AT(30-1)-3374. 51p. Dep.(mn); $3.00(cy), 1(mn) OTS.

Activities in a program to build and install a supercritical water-cooled in-pile fuel testing loop and test fuel in a pressure tube to demonstrate the feasibility of collapsed clad elements in a reactor environment, cooled by supercritical water, are reported. Work toward evaluation of the design of the fuel elements by post-irradiation examination and evaluation of loop performance by analyzing operating data are also reported. Two fuel assemblies manufactured by different methods (pellets and vibratory compaction) will be tested. Two clad materials (16 Cr–20 Ni SS and Incoloy 800) will be included in each assembly. An existing loop design and a large number of loop components previously purchased by Westinghouse were turned over to the AEC under the terms of the contract. The design of the loop is complete and the remainder of the components are being purchased under the contract. Fuel assembly and pressure tube designs were completed. The pressure tube and fuel assemblies are being fabricated. (auth)

5406 PLAIN AND ROLLER BEARINGS FOR EXTREME REACTOR CONDITIONS. [PART] II. F. Helfrich. Atomwirtschaft, 9: 168-74(Apr. 1964). (In German)

Bearings for use in extremely dry helium atmospheres in reactors were studied. All experiments proved that MoS_2 is of supreme importance for the reduction of the coefficients of friction and wear. Graphite, the other dry lubricant which is otherwise frequently used, is not applicable in this case since it loses its lubricating properties because of the dryness of the ambient helium. The pretreatment of the surfaces and the means of introducing the MoS_2 are very important if good adhesion of the lubricant to the metal is to be obtained. Bearings of the same materials but without MoS_2 treatment very rapidly siezed up. Dry lubricated ball bearings were investigated at turning rates of about 100 rpm and temperatures of 150°C with MoS_2 applied after pretreatment of the surfaces by phosphating, etching, and sand blasting; also investigated were grease lubricated ball bearings, oil lubricated bearings and dry lubricated plain bearings. With highly loaded plain bearings at 200°C, a bearing coupling was in general only possible using MoS_2. (auth)

5407 STRUCTURAL PROBLEMS IN REACTOR ENGINEERING. N. W. Murray (Monash Univ., Victoria, Australia). Nucl. Energy, 310-13(Nov. 1964).

Structural problems associated with large cylindrical pressure vessels are considered. Analysis of stresses, specific stress problems, torispherical heads, taper hub flanges, bellows units, erection problems, and access nozzles are discussed. (C.E.S.)

5408 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR CONTROL MEANS. (to Babcock and Wilcox Ltd.). British Patent 968,212. Sept. 2, 1964. Priority date Apr. 4, 1960, Germany.

A reactor control means is described which offers greater sensitivity of flux control. The means include two bodies relatively movable longitudinally one within the other; the mutually facing surface of the bodies are generally cone-shaped so that an annular space between the bodies is formed whose radial dimensions depend on the position of the inner body relative to the outer body. The annular space is filled with a neutron-absorbing fluid, such as BF_3 gas, liquid Cd compounds, etc. The reactor is controlled by moving the inner body up or down. The exact conical shapes of the facing surfaces of the bodies may be varied for different kinds of flux control. This control means may be useful for high-temperature and nonstationary reactors. (D.L.C.)

5409 IMPROVEMENTS IN OR RELATING TO SHIELDING CONSTRUCTION FOR NUCLEAR REACTORS. Donald Young (to United Kingdom Atomic Energy Authority). British Patent 968,216. Sept. 2, 1964. Filed July 25, 1961.

A radiation shielding wall is designed which comprises a double layer of precast concrete blocks, fixed together by means of bolts. The wall is provided with means for preventing radiation streaming through the bolt holes which are of necessity larger than the bolts. The means comprise two sleeves in the respective bolt holes in the two layers; one sleeve forms a tight fit against the surface of the bolt hole, while the other sleeve closely engages the bolt. (D.L.C.)

5410 IMPROVEMENTS IN CORE STRUCTURES OF NUCLEAR REACTORS. Eric Victor Lockney (to Head Wrightson and Co. Ltd.). British Patent 969,471. Sept. 9, 1964. Filed Oct. 16, 1959.

A core structure comprising an assembly of moderator blocks, is designed with means for full compensation of Wigner shrinkage of the components and of an increase in the lattice pitch. In the structure, alternate or certain of the moderator columns are capable of vertical displacement, and support elements are provided between such displaceable bricks and adjacent bricks. The support elements are so shaped and disposed as to bear against the complementary surfaces of the adjacent bricks, and on the occurrence or increase of lateral separation between the adjacent bricks, the elements exert opposed lateral forces thereon, thereby stabilizing the columns laterally. (D.L.C.)

5411 NUCLEAR REACTOR VALVE. Derek Bromley (to United Kingdom Atomic Energy Authority). British Patent 968,759. Sept. 2, 1964. Filed Aug. 28, 1962.

A valve is designed for passing pebbles into and/or out of a reactor which employs pebble fuel elements, such as that described in British Patent 961,084. The valve comprises an inlet channel of diameter at least 5 times larger

than that of the pebbles, a funnel for receiving the pebbles from the inlet channel, an outlet channel of diameter 1.0 to 1.7 times that of the pebbles, and an oscillator and a controller between the funnel and the outlet channel. Both the oscillator and the controller have apertures for passing single pebbles; the oscillator oscillates to impart vibrations to the pebbles in the funnel, and the controller is moved cyclically to pass a single pebble periodically into the outlet channel. (D.L.C.)

5412 NUCLEAR REACTOR SAFETY ROD. John Frederick Ablitt (to United Kingdom Atomic Energy Authority). British Patent 969,089. Sept. 9, 1964. Filed June 13, 1962.

A safety rod system is designed which is biased toward the shutdown position by gravity. The system comprises a guide tube, part of which penetrates the reactor core, and a neutron-absorbing rod within the tube. In operation of the reactor, the rod is lifted by the coolant flow to a level outside the core; if the coolant flow is reduced, the rod falls into the core. (D.L.C.)

5413 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. John Anthony Scott (to English Electric Co. Ltd.). British Patent 974,129. Nov. 4, 1964. Filed Mar. 19, 1962.

A reactor control arrangement is described. Temperature and neutron flux are evened out by channels filled with neutron absorbing elements of varying relative masses to produce the desired conditions. The elements are stainless steel. (T.R.H.)

5414 IMPROVEMENTS IN AND RELATING TO METHOD AND MEANS FOR REFUELLING NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 974,248. Nov. 4, 1964. Priority date Mar. 16, 1960, Germany.

A reactor fueling system is described. A control-rod channel is associated with eight fuel channels. The fuel rods are handled by a tool inserted in the control-rod channel. The fuel rods are moved into the control channel and through the hollow control rods. (T.R.H.)

5415 FEED MECHANISM FOR TRANSFER MACHINE. Paul Jackman, David Humphreys, and John Desmond Parsons (to United Kingdom Atomic Energy Authority). British Patent 974,261. Nov. 4, 1964. Filed Sept. 10, 1962.

A mechanism is described for unloading plate fuel from nuclear fuel sheaths. The plates are pushed up to a sensing and feeding arrangement which removes the plates and places them on a conveyer belt to the sorting and storage magazines. Thus, the moderator and fuel plates are removed and sorted. (T.R.H.)

5416 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 974,547. Nov. 4, 1964. Priority date Apr. 6, 1962, United States.

A control rod drive mechanism is described which simplifies removal of a rack and pinion driven rod. The rod has a slot with a key to prevent its rotating when being driven. Removal of the key allows the rod to rotate, uncouple itself, and be removed. (T.R.H.)

5417 IMPROVEMENTS IN OR RELATING TO GAS COOLED NUCLEAR REACTORS. (to Arbeitsgemeinschaft Versuchsreaktor (AVR) GmbH). British Patent 975,058. Nov. 11, 1964. Priority date Nov. 3, 1962, Germany.

A double-wall arrangement for safer containment of gas coolant loops is described. A sealing chamber encloses the coolant circuit and is filled with an inexpensive inert gas at a slightly higher pressure. Preferably the coolant is He, and the sealing gas is CO_2. Any leak in primary coolant loop allows sealing gas to enter coolant loop and no radioactively contaminated gas escapes. (T.R.H.)

5418 EMERGENCY CONDENSATION ARRANGEMENT FOR NUCLEAR REACTORS. Klaus Traube (to Licentia Patent-Verwaltungs GmbH). German Patent 1,170,563. May 21, 1964. Filed Mar. 14, 1961.

A direct cycle boiling reactor system is described, which is provided with a separate emergency cooling circuit. Connected to this emergency cooling circuit is a container for the condensation of steam during the interval between the rapid shut down of the turbine and the beginning of operation of the emergency cooling circuit. (Gmelin Inst.)

5419 ARRANGEMENT FOR INSTALLATION AND DISASSEMBLY OF AN APPARATUS IN OR OUT OF A REACTOR. Gerhard Friedrich Dise, Hinrich Flessner, and Bernhard Hoffmeister (to Krupp-Ardelt GmbH). German Patent 1,175,369. Aug. 6, 1964. Filed Dec. 21, 1960.

The charging device described includes a shielded housing with an opening on one side, which is seated over the opening of a lock chamber. The lock chamber is flanged to the charging opening of the reactor. The operating parts of the charging device consist of a lead screw drive that is at least two-stepped. The lead screw of the first step is passed through that wall of the housing that is opposite to the opening. (Gmelin Inst.)

5420 APPARATUS FOR THE SHUTTING DOWN OF NUCLEAR REACTORS. Peter Dosch, Hans-Joachim Kraus, and Hans Uhrig (to Gesellschaft für Kernforschung mbH). German Patent 1,175,371. Aug. 6, 1964. Filed Aug. 8, 1962.

The control rod drive consisting of a collision momentum generating device, which accelerates the safety elements and an electromagnetic holding device, was improved. The accelerating force of the collision momentum generating device is much higher than the holding force of the holding device. (Gmelin Inst.)

5421 PNEUMATIC DRIVE FOR THE ABSORBER RODS OF A NUCLEAR REACTOR. Theodor Cyron (to Interatom GmbH). German Patent 1,175,806. Aug. 13, 1964. Filed Feb. 23, 1961.

The control rod drive includes an expansible bellows disposed below a perforated guide tube. The control rod is rigidly attached to the lower end of the bellows in axial alignment therewith. The other end of the bellows is rigidly attached to the upper end of the bellows, which is provided with an inlet opening for the fluid driving agent. The restoring force compressing the bellows is facilitated by the pressure of the reactor coolant medium, which communicates with the interior of the guide tube. (Gmelin Inst.)

5422 REACTOR SAFETY CIRCUITS ACCORDING TO THE 2- OF -3 SYSTEM. Herbert Troeger (to Siemens-Schuckertwerke AG). German Patent 1,176,288. Aug. 20, 1964. Filed June 1, 1962.

A 2 out of 3 safety circuit is given, which prevents unnecessary trips if two different sensing elements located in two different guard lines are faulty simultaneously. Each of the three sensing elements of the same kind has three contacts, which are operated simultaneously. Each of these three contacts is placed in a different guard line. Three contacts operated by signals of the same kind, but which are obtained by 3 different sensing elements, are respectively switched in parallel by partly duplicating each of the guard lines. (Gmelin Inst.)

5423 SAFETY CIRCUITS FOR NUCLEAR REACTORS WITH SELF-INSPECTION. Karl Bamberger and Horst Kaltenecker (to Siemens & Halske AG). German Patent 1,177,262. Sept. 3, 1964. Filed July 24, 1961.

A built-in testing scheme is given, which carries out safety-circuit tests automatically at regular intervals. An impulse generator controls a ring counter, which feeds pulses into the separate guide lines. The pulse duration of these test pulses is short compared to the pulse spacing so that the alarm system, which responds to a continuous signal, is not released while testing. (Gmelin Inst.)

5424 REACTOR SHUT-DOWN APPARATUS USING NEUTRON ABSORBING BALLS. Ronald Hugh Campbell (to United Kingdom Atomic Energy Authority). U. S. Patent 3,147,188. Sept. 1, 1964. Priority date July 20, 1959, Great Britain.

A device was designed for releasably restraining a multiplicity of magnetic neutron-absorbing balls from passage

along a tube. The device comprises magnetic means interposed in the tube and including several pairs of annular pole pieces. Upon demagnetization of the magnetic means, the balls fall into the reactor core to shut it down. (D.L.C.)

5425 NUCLEAR REACTOR CONTROL DEVICE. Frank Bevilacqua and Robert W. Deutsch (to General Nuclear Engineering Corp.). U. S. Patent 3,149,048. Sept. 15, 1964. Filed Dec. 2, 1960.

A reactor control system was designed, which is to be disposed in the core of a reactor employing a poison. It is adapted to be permanently retained in the core of the reactor and to be movable therein. It controls reactivity in the active portion of the reactor while remaining stationary relative to its central longitudinal axis. It consists of a plurality of longitudinally extending stationary members, a plurality of members rotatable about an axis parallel with the longitudinal axis of the device with the stationary and movable members outwardly extending with respect to the axis and alternately arranged. Each has a fuel portion and a poison portion. (M.C.G.)

5426 SEALING AND CENTERING DEVICE FOR ROTARY SHAFT. Gaspard Paul Dreyfus, André Ertaud, Jean Friberg, Robert Galley, Roger Julia, and Jacques Panossian (to Commissariat à l'Energie Atomique). U. S. Patent 3,150,822. Sept. 29, 1964. Priority date Feb. 9, 1961, France.

A rotary seal device is offered which combines the advantages of the Holweck molecular rotary vacuum pump and the fluid bearing type. (T.R.H.)

5427 REACTOR CONTROL WITH THORIUM CONTROL GRID. William C. Redman (to U. S. Atomic Energy Commission). U. S. Patent 3,162,577. Dec. 22, 1964.

A nuclear reactor was designed, which consists of a core with a plurality of vertically disposed clusters of fuel elements immersed in heavy water. The fuel elements are composed of a major proportion of thoria and a minor proportion of enriched urania. The core is approximately twice the height required for criticality. A control grid of thorium of slightly greater than one-half the height of the reactor core is mounted for vertical movement within the core. (AEC)

5428 REACTOR AND APPARATUS FOR CONTROL THEREOF. Abbott Allen (to U. S. Atomic Energy Commission). U. S. Patent 3,162,578. Dec. 22, 1964.

A pneumatically actuated control rod was designed for a nuclear reactor. Specific means for moving the control rod into the reactor at high speed and for decelerating the control rod rapidly are described. (AEC)

Criticality Studies

Refer also to abstract 4578.

5429 (CEA-R-2479) MESURES FINES DANS DES RESEAUX A GRAPHITE. (Fine Measurements in Graphite Lattices). Francois Cogné and Jacques Journet (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 93p. Dep.(mn).

The experiments described have been carried out for the most part in the critical facility MARIUS, and a few during the start up of the EDF.1 power reactor. The first part deals with the fine structure measurements made in various lattices, and with their analysis. Integration over the neutron spectrum of the monokinetic disadvantage factor derived by one method yields results in agreement with the experiments. The second part deals with spectral index measurements (Pu/U, In/Mn) made at room temperature in MARIUS. Comparison are made of experiments with calculations using various thermalization models. Experiments carried out at higher temperatures in EDF.1 are also described. (auth)

5430 (CONF-654-8) EFFECTIVE HOT-CHANNEL FACTORS FOR "FLAT" POWER REACTORS. F. D. Judge and L. S. Bohl (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 2, 1964. Contract W-31-109-eng-52. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The selection of effective hot-channel factors, depending on the number of limiting channels, for evalutation of the power margin of a reactor system is discussed. The maintenance of the desired confidence is considered. (R.E.U.)

5431 (IDO-16985) XENON-135 INDUCED INSTABILITIES OF THE NEUTRON FLUX IN NUCLEAR REACTORS. Gary Marlin Sandquist (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1964. Contract AT(10-1)-205. 286p. Dep.; $6.00(cy), 5(mn) OTS.

An extensive analytic and computer investigation is made of several systems of kinetic equations that describe to varying degrees of accuracy the space and time behavior of the neutron flux, the xenon-135, and the iodine-135 in reactors. Criteria for stability of the neutron flux under the influence of xenon-135 are established, and those factors that significantly affect stability are found and examined. (auth)

5432 (KAPL-M-6185) HOTSTICK—KARE AXIAL POWER DISTRIBUTION PROGRAM FOR THE PHILCO 2000. D. E. Goodman (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 1962. (RPC-5, Revision I). July 10, 1964. Contract W-31-109-eng-52. 15p. ([KAPL-M]-RPC-5(Rev.I)). Dep.(mn); $1.00(cy), 1(mn) OTS.

The determination of axial power distributions in suspected "hot channels" is of major interest in reactor design. HOTSTICK is a Philco 2000 computer program that operates as part of the KARE System to obtain these distributions as a useful adjunct to normal KARE calculations. (auth)

5433 (MITNE-33) ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS OF THE BEHAVIOR OF THERMAL NEUTRONS IN LATTICES OF URANIUM METAL RODS IN HEAVY WATER. R. Simms, I. Kaplan, T. J. Thompson, and D. D. Lanning (Massachusetts Inst. of Tech., Cambridge). Oct. 11, 1963. Contract AT(30-1)-2344. 224p. (NYO-10211). Dep.; $6.00(cy), 4(mn) OTS.

Measurements of the intracellular distribution of the activation of foils by neutrons were made in lattices of $\frac{1}{4}$-inch diameter, 1.03% ^{235}U, uranium rods moderated by heavy water, with bare and cadmium-covered foils of gold, depleted uranium, lutetium, europium, and copper. The measurements were made in the M.I.T. Heavy Water Lattice Facility with source neutrons from the M.I.T. Reactor. Two lattices were studied in detail. The more closely packed lattice had a triangular spacing of 1.25 inches, and the less closely packed lattice had a triangular spacing of 2.5 inches. The results of the experiments were compared to one-dimensional, 30-energy group, THERMØS calculations based on the available energy exchange kernels. The comparison indicated that the approximation that the hexagonal cell may be replaced by an equivalent circular cell (the Wigner-Seitz approximation) can lead to serious discrepancies in closely packed lattices moderated by heavy water. A modified one-dimensional, and a two-dimensional, calculation were shown to predict the intracellular activation distribution in the closely packed lattice. An analytical treatment of the problem of the flux perturbation in a foil was developed and compared to the experimental results obtained using gold foils of four different thicknesses in the lattice cell; the method was shown to be adequate. An analytical method to treat the effect of leakage from an exponential assembly was formulated; the results indicated that only in small exponential assemblies would leakage be a significant problem in intracellular flux measurements. A method was developed to predict the cadmium ratio of the foils used in the lattice cell; comparison with available measurements with gold foils indicated good agreement between theory and experiment, except for a lattice having very large ratios of moderator volume, to fuel volume, e.g., 100:1. Calculations of the fuel disadvantage factor by the method of successive generations for gold, lutetium, and europium detector foils

were compared to the results of THERMØS calculations, because THERMØS was shown to predict the experimental distributions. The comparison indicated that the method of successive generations is a good alternative to the THERMØS calculation, if all that is required is η and the thermal utilization. (auth)

5434 (NP-14501) AN INVESTIGATION OF NUCLEAR EXCURSIONS TO DETERMINE THE SELF-SHUTDOWN EFFECTS IN THERMAL, HETEROGENEOUS, HIGHLY ENRICHED, LIQUID-MODERATED REACTORS (thesis). John Robert Fagan (Kansas State Univ., Manhattan. Engineering Experiment Station). July 1962. 130p.

Kansas State Univ. Eng. Expt. St., Spec. Rept. No. 23.

The safe operation of nuclear reactors is imperative if there is to be increased engineering application of these systems. Transient reactor experiments, such as the SPERT tests, have demonstrated that thermal, heterogeneous, liquid-moderated reactor systems will safely shut themselves down following step and ramp insertions of limited amounts of excess reactivity. It is important that a model based on the nuclear, thermodynamic, and hydrodynamic properties of the reactor system be developed to explain this phenomena so that it can be used in the design of new systems. Equations for the fine structure of the temperature distribution in a unit cell of a heterogeneous reactor during a transient burst were derived based on the known power and fuel surface temperature distributions. A model based on recognized shutdown effects was developed to calculate the excess reactivity during a transient using the temperature distributions to define the deposition of energy. The calculated excess reactivities show this model to be satisfactory. The effect on reactivity due to steam formation required one empirical parameter that can probably be removed when a greater knowledge of transient boiling is available. (auth)

5435 (WAPD-TM-334(Rev.)) CINDER—A ONE POINT DEPLETION AND FISSION PRODUCT PROGRAM. T. R. England (Westinghouse Electric Corp. Bettis Atomic Power Lab., West Mufflin, Penna.). Aug. 1962. Revised June 1964. Contract AT(11-1)-Gen-14. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

CINDER is a generalized, 4 energy-group, one-point depletion and fission product program. It is based on an evaluation of a programmed, general analytical solution of nuclides coupled in any linear sequence of radioactive decays and neutron absorptions. Time-dependent variations in nuclide cross sections and neutron fluxes are approximated by specifying a sequential set of values considered constant during associated time-increments, the duration of each being specified by the user. The desired depletion and fission product chains and all physical data are specified by the user thus providing the ability to tailor the program to individual needs. The program incorporates a self-check against errors which fundamentally originate from the computer's limitation to a finite number of digits. The program is presently limited to 400 total nuclides formed into chains of 17 nuclides, or less. Ten nuclides may be fissile acting as fission product sources and contributing to power. Up to 99 time-steps of arbitrary length are permitted. Program output at each time-step provides the individual nuclide number densities, activities, macroscopic and barns/fission poisons and other data. A summation of the group poisons and activities of nuclides selected by the user is also provided. The BKS system for Philco 2000 is employed in the operation of the FORTRAN program (MO102). (auth)

5436 (WAPD-TM-468) TNTO2—A THREE-DIMENSIONAL NEUTRON FLUX SYNTHESIS AND DEPLETION CALCULATION COMPUTER PROGRAM. C. A. Flanagan, R. J. Breen, O. J. Marlowe, and A. J. Vigilotti (Westinghouse Electric Corp. Bettis Atomic Power Lab., West Mifflin, Penna.). Aug. 1964. Contract AT-11-1-GEN-14. 103p. Dep.(mn); $4.00(cy), 2(mn) OTS.

TNTO2 is a three-dimensional neutron flux synthesis and depletion code for Philco 2000 made up by TNT2A, which determines the integrals of the products of two-dimensional trial and weight functions, TNT2B, which performs the depletion calculations, and TNT2C, which performs re-depletion calculations for detailed power distributions. (R.E.U.)

5437 OPTIMUM CONDITIONS FOR SHUTTING DOWN REACTOR OPERATION. V. N. Artamkin, G. V. Vasenkova, I. V. Otroshchenko, and R. P. Fedorenko. At. Energ. (USSR), 17: 189-93(Sept. 1964). (In Russian)

Conditions of reactor shutdown (optimum control) are considered which enable the maximum value of reactor poisoning to be minimized by maneuvering the reactor power during the given time interval (on the order of several hours). The problem of finding optimum control was solved by an approximation method devised by R. Fedorenko for the numerical solution of nonlinear problems of optimum control. This method presents an iteration procedure in which some initial (not optimum) control is successively varied with the goal of diminishing the functional value. This procedure leads rather quickly to a control sufficiently near to optimum. Analysis of a large number of the numerical solutions allowed a highly probable approximation of the simple structure of the exact solution of the problem. (tr-auth)

5438 SPACE-ENERGY DISTRIBUTION OF THERMAL NEUTRONS IN A HETEROGENEOUS REACTOR. N. I. Laletin. At. Energ. (USSR), 17: 193-8(Sept. 1964). (In Russian)

The space-energy distribution of thermal neutrons in a heterogeneous reactor is determined in the heavy-gas model approximation. The moderator is considered nonabsorbing, and the fuel elements are not neutron moderating. To describe the energy dependence of the solutions, functions associated with the usually employed Laguerre polynomials are used in addition to these polynomials, a process which turns out to be very convenient. Possible ways of giving a more precise definition to the results are examined. (tr-auth)

5439 OPTIMIZATION OF XENON POISONING BY OPTIMIZATION OF BUILD-UP OR RECOVERY. Yoshikumi Shinohara and Jean Valat. Compt. Rend., 259: 1836-9 (Sept. 14, 1964). (In French)

The Pontryagin maximum principle associated with some physical consideration makes it possible to find the optimum shut-down program of minimum duration extending as much as possible the instant of poisoning or making the instant of recovery as soon as possible. (tr-auth)

5440 AN ELECTRICAL RESISTANCE NETWORK ANALOGUE FOR THE STUDY OF SQUARE CORE REACTORS. E. V. R. Rao and R. Vedam (Atomic Energy Establishment, Trombay, India). Indian J. Pure Appl. Phys., 2: 312-16(Oct. 1964).

The analogy between the neutron diffusion equation and the equation describing the flow of current in a conductor was used to construct a resistance network for studying the characteristics of a square core swimming pool reactor like the Apsara at Trombay, Bombay. The resistances of the network were chosen such that they represent the processes, like diffusion, slowing down, and absorption, occurring in a reactor. Two networks coupled to each other were used to represent the two-group neutron diffusion equation. By manual iteration the steady-state spatial distributions of fast and slow neutron fluxes were obtained for different configurations of the core (with full reflector and with partial reflectors). The infinite multiplication factor for criticality was also obtained. The flux distribution obtained from the electrical analog studies agrees with the flux distribution obtained from the approximate expression derived from the assumption that the variables in the function for flux ϕ (x,y) can be separated so that ϕ (x,y) = X(x) · Y(y). (auth)

5441 THE KINETIC BEHAVIOR OF A REACTOR COMPOSED OF G LOOSELY COUPLED CORES; INTEGRAL FORMULATION. A. Belleni-Morante (Università, Florence). J. Nucl. Energy, Pt. A & B, 18: 547-59(Oct. 1964).

The kinetic behavior of a reactor composed of G loosely coupled cores was studied. The set of the G neutron densities $n_1(t), n_2(t), \ldots, n_G(t)$ in the G fuel regions were considered as a neutron density matrix which was shown to be the solution of an integral equation of the Volterra type. Some numerical results were found for the particular case of the UTR-10 Reactor (G = 2) and for one-core reactors (G = 1). (auth)

5442 ON THE DETERMINATION OF THE REACTOR'S TRANSFER FUNCTION BY ANALYZING THE FREQUENCY SPECTRUM OF FLUCTUATIONS. I. Purica, I. Iftode, and I. Girlea (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 351-6(1964).

The transfer function of the reactor was determined by analyzing the natural fluctuations of the neutron flux. In this case, the reactor was considered as a determinate system (having a known mathematical description), the input of which is actuated by a statistical source with a constant power spectrum as a function of frequency ("white" noise). The parameters of the transfer function of the reactor may be determined by measuring the moment of second order (variance) of the fluctuations in the neutron flux. The frequency spectrum was analyzed by use of a frequency analyzer and an analog computer. (auth)

5443 CRITICAL REGION IN A REACTOR WITH NONLINEAR COUPLING BETWEEN NEUTRON FLUX AND TEMPERATURE IN MULTIGROUP APPROXIMATION. O. B. Moskalev. Zh. Vychislitel. Mat. i Mat. Fiz., 4: 599-604(1964).

A convex thermal reactor with an arbitrary number of sections is considered, with each section characterized by its own neutron-substance interaction cross section. It is assumed that the neutron distribution in the reactor can be represented by a system of multigroup equations and that the reactor temperature is determined by the thermal neutron flux φ_N only. The multigroup equations have the general nonhomogeneous, linear integral form $\varphi_j(P) = \int_v dP' K_j(P, P', B\varphi_N)\, \sigma_j(P', B\varphi_N)\, \varphi_j(P') + f(P, B\varphi_N)$. This equation is shown to have a unique solution for a fixed f and thus can be represented by some continuous operator L_j acting on f so as to reduce the multigroup equations to the form $\varphi_N(P) = \int_v dP' K_N(P, P', B\varphi_N) [\sigma_N(P', B\varphi_N)\, \varphi_N(P') + L\varphi_N(P')]$. The right side of this equation is further represented by the nonlinear operator $A(\varphi)$, which is shown to be continuous and dense. It is explained that $A(\varphi)$ acting on some thermal neutron flow $\varphi(P)$ produces a number of secondary thermal neutrons at point P after a single interaction. This is represented by the inequality $A(t\varphi)\, t\varphi \geq tA(\varphi)\varphi$, $(0 \leq t \leq 1)$. Finally, the function $\sigma\varphi + L\varphi$ is found to possess the properties of concavity. (ATD)

Design and Feasibility

5444 METHOD FOR THE OPERATION OF A NUCLEAR REACTOR AS WELL AS REACTOR AND NUCLEAR FUEL FOR CARRYING OUT THE METHOD. Joachim Nitschke, Oswald Riedel, and Berthold Frank. German Patent 1,172,380. June 18, 1964. Filed Sept. 19, 1960.

The reactor has a funnel-shaped active portion and the inlet of the gaseous fluid is located at the lower end of the funnel. The grain size of the nuclear fuel varies from 0.5 to 10 mm, preferably from 2 to 6 mm. By using a funnel the vortex layers for different gas velocities are located in different parts of the active portion. (Gmelin Inst.)

5445 METHOD FOR THE CONTROL AND OPERATION OF A HOMOGENEOUS NUCLEAR REACTOR. Olle Lindstroem (to Allmanna Svenska Elektriska Aktiebolaget). German Patent 1,175,370. Aug. 6, 1964. Priority date, Dec. 22, 1959, Sweden.

The reactor vessel is in communication with at least one subcritical auxiliary vessel and the moderator content of the reactor is distributed between the reactor vessel and the auxiliary vessel by regulating the pressure of the gas phases in the respective vessels with a gas caused to flow between the auxiliary vessel and the reactor vessel and/or the primary steam circuit. The gas flows via conduits containing adjustable regulating means producing a resistance to the flow of gas. (Gmelin Inst.)

5446 HOMOGENEOUS-LIQUID METAL-FAST REACTOR. Roland Philip Hammond, Harold M. Busey, and John R. Humphreys, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,161,570. Dec. 15, 1964.

A homogeneous nuclear reactor was designed, which uses molten plutonium as a fuel and liquid sodium as a coolant. The reactor has a sodium jet pump, a baffle and core shield system, and a heat exchanger, all located within the reactor vessel. This allows the transfer of both the heat and fission products to the sodium, separates the fuel from the now contaminated sodium, and then returns the purified, cooled fuel to the core. (AEC)

5447 BOILING-WATER NUCLEAR REACTOR. Joseph M. Harrer, Charles F. Bullinger, and Verne M. Kolba (to U. S. Atomic Energy Commission). U. S. Patent 3,161,571. Dec. 15, 1964.

A boiling-water reactor was designed, with fuel assemblies consisting of an open-top basket-like fuel holder removably set in a lower support grid and meshing with an upper guide grid and two fuel units. Each fuel unit is symmetric about a plane located midway of the ends of the unit and perpendicular to the longitudinal axis of the unit and has the same cross-sectional shape as the holder. The fuel units are removably disposed in each fuel holder. (AEC)

Fuels

Refer also to abstracts 4065 and 4333.

5448 (EURAEC-1199) PLUTONIUM RECYCLING. Quarterly Report No. 15, April 1–June 30, 1964. (France. Commissariat a l'Energie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). Work Performed under United States–Euratom Joint Research and Development Program. Contract 037-60-12-RDF. 4p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The fabrication of plutonium-uranium fuel elements is discussed. (N.W.R.)

5449 (HW-67979) CONTROL SYSTEM ANALYSIS—NICKEL PLATE PROCESS. B. E. Dozer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 3, 1961. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are presented of a computer analysis of a controller to determine its adequacy in controlling a chemical process for Ni plating fuel elements. (J.R.D.)

5450 (ORNL-3627(p.153-76)) DEVELOPMENT OF THE THORIUM FUEL CYCLE. (Oak Ridge National Lab., Tenn.).

Progress in development of the fuel cycle technology required for economical power production in Th-fueled reactors is reported. Oxide fuels and the preparation of microspheres of those fuels are being emphasized, but some work on preparation of Th–U carbides and other systems, such as cermets, is being carried out to exploit the versatility of the sol-gel process. During the year, the Kilorod Program was successfully completed; approximately 1000 tubes filled with ThO_2–$^{233}UO_2$ were produced in using the sol-gel process for oxide preparation and vibratory compaction as a means of remotely fabricating ThO_2–$^{233}UO_2$ fuels. Also during the year, the preliminary design of the Thorium–Uranium Fuel Cycle Development Facility was completed, and detailed design was started. (auth)

5451 (ORNL-3627(p.249-55)) REACTOR EVALUATION STUDIES. (Oak Ridge National Lab., Tenn.).

A program in which optimization studies are prepared for various reactor types and their associated fuel cycles

respectively is described. Activities during the year included completion of the fuel-shipping-cask drop tests and correlation of the data obtained, preparation of computer costing codes (MYRA and NORA) for fuel shipping optimization, preparation of a criticality report for use in fuel-processing plant design, and an economic study comparing the PWR reactor and fuel cycle costs with those of six advanced converter reactors. (auth)

5452 MATERIALS FOR NUCLEAR REACTOR FUEL ELEMENTS. Kurt Fritz (Waagner-Biro AG, Vienna). Chem.-Ingr.-Tech., 36: 833-49(Aug. 1964). (In German)

Fuel elements are shown to be of decisive importance in heterogeneous nuclear reactors. To some extent, new materials and processes must be employed in their manufacture. The various materials and combinations of materials involved are discussed, and details of special methods of production are given. (auth)

5453 THERMAL BOWING OF FUEL RODS DURING TRANSIENTS. W. K. Ergen (Oak Ridge National Lab., Tenn.). J. Nucl. Energy, Pt. A & B, 18: 537-45(Oct. 1964).

An analytical solution for fuel rod bowing is presented for the case in which the temperature gradient varies with time and is also in the direction of the rod axis. Comparison is made with experimental data from power excursions on a low-enrichment UO_2 core at SPERT-I. The comparison supports the view that the shape of the stainless-steel-clad fuel rods, which were filled with powdered UO_2, is determined by the cladding and that the UO_2 only contributes inertia to the transient bowing. The agreement between computation and experiment is quite good, as far as the general features of the time dependence and the maximum deflection is concerned. The theoretical curve shows a somewhat stronger oscillatory character than the experimental one. (auth)

5454 URANIUM MONOCARBIDE FUELS. Harry Pearlman and C. W. Wheelcock (Atomics International, Canoga Park, Calif.). Proc. Am. Power Conf., 26: 283-91 (1964).

The design and fabrication of uc fuel elements is briefly discussed, using the fuel elements for the Hallam Nuclear Power Facility (HNPF) and the Large Sodium Graphite Reactor (LSGR) as examples. The results of in-pile tests of model elements are considered in relation to HNPF and LSGR design limits. Uc fuel cycle coats are discussed, together with the results of a parametric study of uc fuel elements. (D.C.W.)

5455 IMPROVEMENTS IN OR RELATING TO FUEL PIN ASSEMBLIES. (to Babcock and Wilcox Co.). British Patent 968,321. Sept. 2, 1964. Priority date Aug. 23, 1962, United States.

A fuel pin assembly is designed with spacers for positioning the fuel pins relatively to each other in the assembly. Each spacer is formed from a short length of a rectangular tube and has at least three inwardly projecting bosses between which a fuel pin lies. Some or all of the bosses are resiliently attached to the spacer to urge the fuel pin into contact with all of the bosses. (D.L.C.)

5456 NUCLEAR REACTOR FUEL ASSEMBLIES. (to Sulzer Brothers Ltd.). British Patent 968,450. Sept. 2, 1964. Priority date June 13, 1962, Switzerland.

A fuel assembly for a reactor using pressure tubes is designed which enables the coolant to flow more uniformly around the fuel rods, protects the pressure tube against overheating, and uses the space between fuel rods and pressure tube for moderation. The fuel assembly comprises a pressure tube containing shaped parts which are made of a moderator (e.g., graphite) and which have several coolant flow channels, each of which accomodates at least one fuel rod. The pressure tube is closed at one end, and the interior surface of the tube and the shaped parts define an outer coolant flow passage. (D.L.C.)

5457 IMPROVEMENTS IN OR RELATING TO FUEL PIN ASSEMBLIES FOR NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 969,131. Sept. 9, 1964. Priority date Nov. 24, 1961, United States.

A fuel pin assembly is designed with improved supporting means. The supporting means comprises a pair of spacer strips which are bent to form openings between the two strips for a row of fuel pins; the strips also contact each other and adjacent strips in other rows. A stiffening support member is provided with slots for fitting over the spacer strips. (D.L.C.)

5458 HEAT EXCHANGER ESPECIALLY FOR NUCLEAR FUEL ELEMENT. Ennemond Maillet (to Commissariat à l'Energie Atomique). British Patent 969,154. Sept. 9, 1964. Priority date Feb. 8, 1962, France.

A tubular fuel cell for use in a power tube of a reactor is designed for improved contact between the liquid film and the heating wall. The cell comprises an outer liner divided into two portions by an intermediate partition with each one of the portions comprising an inlet duct for a liquid cooling phase and around the duct a plurality of tubular elements for vaporizing the liquid. Radial throttling ducts are provided between the inlet duct and the tubular elements to form a liquid film with rotating motion on the inner wall of the elements. The tubular elements are surrounded by annular elements of fissile materials. (D.L.C.)

5459 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Walter Berndt Carlson (to Babcock and Wilcox Ltd.). British Patent 975,152. Nov. 11, 1964. Filed May 17, 1960.

A finned fuel can is described. The circumferentially extending fins in two sets slope in opposite directions relative to the longitudinal axis of the can. These are separated by a splitter formed from the can. (T.R.H.)

5460 NUCLEAR FUEL ASSEMBLY. Shepherd Rigg and David John Ashcroft (to United Kingdom Atomic Energy Authority). British Patent 975,297. Nov. 11, 1964. Filed Nov. 14, 1962.

A nuclear fuel cluster assembly is described. Fuel rods are arranged in a tubular casing with a central spacer column which is fluted and flexible. A wire wound helically on the rods spaces them from the casing and from the central spacer. (T.R.H.)

5461 NUCLEAR REACTOR FUEL ELEMENT AND METHOD OF PREPARATION. Walter Blomeyer and Guenther Schneider (to NUKEM GmbH). German Patent 1,171,544. June 4, 1964. Filed Nov. 4, 1960.

The nuclear fuel element described consists of a metallic fuel and a metallic sheath. Between the metallic sheath and the fuel there is a layer of chromium (4 to 6 μ) sandwiched between two nickel layers (3 to 5 and 7 to 10 μ). After sheathing the coated fuel body the fuel element is heated at a temperature of about 600°C and at a pressure of about 80 atm. (Gmelin Inst.)

5462 NUCLEAR REACTOR FUEL ELEMENT WITHOUT PROTECTIVE CLADDING. Christoph Steinert (to Deutsche Babcock & Wilcox-Dampfkessel-Werke). German Patent 1,171,993. June 11, 1964. Filed Oct. 7, 1960.

An unclad nuclear fuel element is described, which has good heat conducting properties but is impermeable for fission products. This fuel element consists of particles or fibers of glass or quartz containing fissionable or breeder material, which are united with graphite powder by sintering. (Gmelin Inst.)

5463 METHODS FOR OPERATION OF ATOMIC REACTOR FUEL ELEMENTS AND FOR THEIR PREPARATION. Harry N. Schludi. German Patent 1,172,781. June 25, 1964. Filed Apr. 14, 1960.

In order to avoid thermal stresses and deformation the fuel elements are heated from outside the reactor in case of a reactor shut-down or a lowering of the reactor power. The fuel may be operated in the γ-phase when uranium metal is used or in a liquid phase. The heating of the elements is carried out during the fabrication process while the cans are filled with the fuel material. (Gmelin Inst.)

5464 NUCLEAR REACTOR FUEL ROD. Walter Zeller (to Siemens-Schuckertwerke AG). German Patent 1,177,261. Sept. 3, 1964. Filed Mar. 5, 1960.

The fuel rod includes a tubular container enclosing a tubular space, which is subdivided into gas-tight chambers by arrangement of metallic partition walls. The fissionable material is located within the gas-tight chambers. Damage of the partition walls by over-heating is avoided by providing heat-insulating elements between these walls and the fissionable material. These elements are made of ceramics, graphite, or graphite coated by zirconium. (Gmelin Inst.)

5465 NUCLEAR REACTOR FUEL. Russell L. Crowther (to General Electric Co.). U. S. Patent 3,147,191. Sept. 1, 1964. Filed Jan. 25, 1961.

A power reactor core is designed to reduce the flux and power peaking due to slabs of moderator between fuel assemblies. This reduction is accomplished by means of compensation elements containing ^{232}Th and located in the local regions of flux peaking. These compensation elements absorb more thermal neutrons than the uncompensated elements elsewhere, thereby reducing the flux peaking. Several embodiments of fuel assemblies for use in such a manner are described. (D.L.C.)

5466 NUCLEAR FUEL RODS. René Lemaitre (to Societe Indatom). U. S. Patent 3,147,192. Sept. 1, 1964. Priority date Jan. 27, 1959, France.

A method is given for improving the thermal conductivity of a fuel rod comprising stacked uranium oxide pellets in a metallic sheath, so that the specific thermal power in the reactor can be increased. The method comprises partitioning of the rod by layers or thin pellets of a conductive oxide such as BeO, MgO, or Al_2O_3. In one form of the method, the uranium oxide pellets are covered with a thin BeO coating. (D.L.C.)

5467 METHOD OF FABRICATING NUCLEAR FUEL ELEMENTS AND THE LIKE. Samuel Storchheim (to Alloys Research and Manufacturing Corp.). U. S. Patent 3,150,973. Sept. 29, 1964. Filed July 2, 1958.

A powder metallurgy technique for fuel element fabrication is described. The powder core is surrounded by powder cladding on all six sides and subjected to hot rolling. A variety of core and clad materials are possible. The plates thus produced are radiographed, sheared, and brazed into fuel assemblies. (T.R.H.)

5468 ENCASED FUEL. James R. Johnson and Harold G. Sowman (to Minnesota Mining and Manufacturing Co.). U. S. Patent 3,151,037. Sept. 29, 1964. Filed Feb. 21, 1961.

A coated particle reactor fuel material is described. Granules of UO_2 and C (9:1) are mixed with Thermatomic carbon and fired at 1000°C and then at 2550°C to produce granules about 100 – 200 μ in diameter. These can be hydrided at 1300°C. They are then sprayed with carboxymethyl cellulose and heated at 1300° – 1400°C to form a pyrolytic carbon coating about 30μ thick. (T.R.H.)

Power and Power-Breeder Reactors

Refer also to abstract 4717.

5469 (CEA-R-2522) L'INSTRUMENTATION DANS LES CIRCUITS D'ESSAIS RAPSODIE 1 ET 10 MW—DEBITMETRES, MANOMETRES, INDICATEURS DE NIVEAU INDICATEURS DE BOUCHAGE. (Instrumentation in the RAPSODIE Test Circuits of 1 and 10 Mw—Flowmeters, Manometers, Level Indicators, and Blockage Indicators). Jean-Paul Delisle and Noeel Lions (France. Commissariat a l'Energie Atomique. Centre d'Etudies Nucleaires, Saclay). Aug. 1964. 53p. Dep.(mn).

The main measuring instruments, which operate in the presence of liquid metals and which were developed by the liquid metal section over the last few years, are electromagnetic flowmeters, differential manometers, level indicators, and blockage indicators. Results are given from 1 and 10 Mw test circuits, together with the conclusions drawn about their possible use in the Rapsodie reactor. The flow-rate measurements are carried out using electromagnetic flowmeters with permanent magnets. The reliability of these instruments is studied. The measurements show that the induction in the space between the poles is very constant with time and in the presence of the prevailing demagnetization phenomena to which the magnets are subjected. The differential manometers placed in the test circuits are very accurate. It is nevertheless necessary to carry out some technological modifications on them in order that they may operate satisfactorily over long periods. The continuous and discontinuous level-indicators tested operate on the principle of a change in resistance. Studies carried out on the test loops of the reliability and of the accuracy of this equipment show the existence of phenomena connected with the condensation of sodium vapor on the upper parts of the reservoir, and show the importance of the condensed deposits when the oxygen content of the covering gas is appreciable. From the various blockage indicators tried out, the one chosen for use in the reactor circuits is an automatic model with continuous recording. The development and testing of this apparatus on an industrial scale circuit makes it possible to show clearly an effect of a double blockage temperature. (auth)

5470 (DLCS-36403) SHIPPINGPORT OPERATIONS—FROM POWER OPERATION AFTER SECOND REFUELING TO POWER OPERATION AFTER THIRD REFUELING, OCTOBER 24, 1961–JANUARY 30, 1963. L. H. Kemmet, ed. (Westinghouse Electric Co. Bettis Atomic Power Div., Pittsburgh) and R. D. O'Hara, ed. (Duquesne Light Co., Shippingport, Penna.). Contracts AT(11-1)-292 and AT (11-1)-Gen-14. 268p. Dep.; $6.00(cy), 3(mn) OTS.

The operation and modifications made to the Shippingport Pressurized Water Reactor and Station are evaluated from October 24, 1961 to January 30, 1963. Information is included on testing, training program, physics performance, thermal and hydraulic performance plant performance and modifications, operational chemistry and radioactive contamination experience, and the third refueling of Core I. (N.W.R.)

5471 (DLCS-5000964) MONTHLY OPERATING REPORT [ON PWR OPERATIONS], SEPTEMBER 1964. Duquesne Light Co., Shippingport, Penna.). Contract AT (11-1)-292. 40p. Dep.(mn); $2.00(cy), 2(mn) OTS.

Shippingport Atomic Power Station remained shutdown for modification of the reactor plant for Core 2 operation, overall refueling operation, and the main turbine overhaul. The removal and preparation for disposal of spent resin from the RWD underground storage tanks were completed. Conditions related to radioactive contamination were normal and personnel radiation exposures were within specified limits. Stator mechanisms and P. I. coils were installed on the reactor head and electrically checked. The flux wire guide tubing was also installed and pressure tested. Other work of the overall refueling operation included the installation of mechanism component cooling water lines and the partial installation of blanket insulation on the reactor head. (auth)

5472 (EUR-1841.f) UTILISATION DU PLUTONIUM DANS LES REACTEURS A NEUTRONS THERMIQUES ET DANS LES REACTEURS A NEUTRONS RAPIDES. (Utilization of Plutonium in Thermal and Fast Reactors). J. Bussac, A. Kania, A. Meyer-Heine, G. Vendryes, and C. P. Zaleski (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Cadarache). 1964. 66p. (CONF-178-5). Dep.(mn).

From European Atomic Energy Society's Symposium on Fuel Cycles for Power Reactors, Baden-Baden, Ger., Sept. 1963.

The plutonium-producing aspect of thermal reactors is uescribed. A comparison is made of the isotopic composition and amount of plutonium produced by reactors fueled

with natural or slightly enriched uranium. These reactors are then considered as plutonium consumers, either in situ or through a possible fuel enrichment with plutonium. The possibilities and limitations of this last solution are discussed. The advantages of burning plutonium in fast reactors are discussed. Some indications on the expected features of future 1000-Mwe fast reactors are given. After some considerations about the economics of this reactor type, the possible development of thermal and fast reactors which appear to complement each other, is outlined. It is pointed out that the French plutonium supplies should be sufficient to fuel a 100 Mwe fast reactor by 1970 and a 1000 Mwe fast reactor between 1975 and 1980. (auth)

5473 (GA-4622) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1963. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 31, 1963. Contract AT(04-3)-187. 45p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Research and development are reported on reactor components, reactor physics, and reactor materials. Activities related to construction and procurement are also reported. (J.R.D.)

5474 (GEAP-4641) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Fifteenth Progress Report, January–June 1964. C. L. Howard, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 15, 1964. Contract AT(04-3)-189. 84p. Dep.; $3.00(cy), 2(mn) OTS.

Research is reported in a program aimed at extending fuel life information on oxide fuel at high power operation and at raising performance limits of these fuels. Fuel irradiations were terminated, and examinations and analyses of the fuel are in progress. (J.R.D.)

5475 (GEAP-4726) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 8. C. L. Howard (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 62p. (EURAEC-1246). Dep.(mn); $3.00(cy), 1(mn) OTS.

The specification of the computer system and calculational methods was formulated. The detailed computer programs are being written and tested. The major effort is on the channel flow rate, relative nodal power, monitor, and scan portions of the program. The conceptual design of the instrumented assemblies was completed and submitted for approvals. A movable ion chamber system was proposed as a design alternate. Preliminary calculations indicate that the present core could be safely operated at about 150% or more of the present power rating. Future analysis will examine the capability of subsequent cores designed for higher output. The conceptual design of the control rod oscillator system was completed, and equipment sizing calculations were made. (auth)

5476 (HW-64116) EVALUATION AND TESTING OF THE PRTR CONTROLLER UTILIZING AN ANALOG COMPUTER. W. D. Cameron (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1, 1960. Contract AT(45-1)-1350. 25p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

The transient response and frequency response of the closed-loop reactor system were simulated to demonstrate operation of the controller. The transient response of the reactor to disturbances in reactivity and power was obtained at power levels of 10, 30, and 70 Mw. Frequency response was obtained with oscillations assumed to occur in reactivity, power level, or control valves at 10, 30, and 70 Mw for two disturbance magnitudes. The controller was used to control the simulated reactor to obtain information on reactor characteristics. (R.E.U.)

5477 (HW-80206) APPROACH TO CRITICAL AND CALIBRATION EXPERIMENTS IN THE PLUTONIUM RECYCLE CRITICAL FACILITY. R. A. Bennett and L. C. Schmid (General Electric Co. Hanford Atomic Products, Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 54p. Dep.; $3.00(cy), 2(mn) OTS.

The Plutonium Recycle Critical Facility (PRCF) is designed for investigations of reactor phenomena associated with either D_2O or H_2O moderator. The report describes the initial approach to critical experiment and power level, control rod, and moderator level calibration experiments conducted in the PRCF moderated with D_2O. Results of measurements of the longitudinal and radial flux distribution are included separate from the power calibration. Control rod calibration results include integral and differential worth measurements as measured by positive periods. Moderator level calibration results include the integral and differential worth of moderator level changes between 93 and 105 in. In a few cases the experimental results are compared to analytical results using three-group diffusion theory. The reactor is critical at a moderator level of 105 in. with 25 UO_2 fuel clusters surrounded by 30 Pu-Al fuel clusters at an 8 in. lattice spacing. Diffusion theory adequately describes the spatial distributions of the thermal-neutron density. The maximum flux in the reactor is 4.6×10^8 neutrons/cm^2 sec at 100 w total power. The control rods are worth approximately 2 mk. The moderator level coefficient of reactivity is 0.16 mk/in. at 105 in. (auth)

5478 (NAA-SR-8474) EVALUATION OF COOLANT IMPURITY REMOVAL EQUIPMENT AT THE OMRE. P. Barbour and W. W. Davis (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 127p. Dep.; $4.00(cy), 3(mn) OTS.

The experimental application of centrifugal clarification, precoat filtration, conventional filtration, and adsorption to the removal of impurities from a by-pass stream of irradiated reactor coolant at the Organic Moderated Reactor Experiment is described and evaluated. Included is an evaluation of full-flow filtration of the reactor coolant through a 40-micron woven wire filter. Some aspects of the theory of cleanup equipment performance are also discussed. The data indicate that, of the methods studied, combined by-pass filtration through 2- to 3-micron glass-spool cartridge filters and fixed-bed adsorption employing Attapulgus clay show the most promise for maintaining organic reactor coolant in a nonfouling condition during reactor power operation. (auth)

5479 (NAA-SR-9501) 1000-Mwe SGR CORE OPTIMIZATION STUDIES. H. Rood (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 50p. Dep.; $3.00(cy), 1(mn) OTS.

Core optimization studies were made to investigate the technical and economics characteristics of a 1000-Mw(e) SGR. The design of this plant is a logical extension of the SGR technology developed to date, as demonstrated by the SRE and the Hallam Reactor. The fuel element is based on present technology or a near-term extension of it. The fuel material is hypostoichiometric UC, clad in sealed stainless steel tubes, sodium bonded. The average discharge exposure assumed attainable with this fuel, at a maximum center temperature of 2000°F, is 25,000 Mwd/MTU. The four parameters taken as independent variables for the optimization study are: fuel rod diameter, number of fuel rods per element, fuel element lattice spacing, and maximum fuel temperature. The optimization study was limited to the reactor core by fixing the coolant inlet and outlet temperatures at reasonable values determined by previous studies. Some of the other fixed parameters are: cladding material and thickness, process tube material and thickness, core length, pressure drop, and maximum fuel exposure. Given these parameters and a value for each of the independent variables, all other core parameters were calculated. Also calculated for each case were fuel cycle costs, for private and government fuel ownership, and incremental capital cost. The sum of these, the incremental

total cost, is the parameter to be minimized. The optimized fuel element selected is an 18-rod cluster of 0.500-in.-diameter fuel rods, set on a square lattice spacing of 10.25 in. For this case, at a maximum fuel temperature of 2000°F, the equilibrium core fuel cycle cost is 1.34 mill/kwh for government fuel ownership, and 1.49 mill/kwh for private fuel ownership at 10% lease rate. (auth)

5480 (NAA-SR-10152) DESIGN OF AN EXPERIMENTAL BOWABLE FUEL ELEMENT FOR THE SRE. C. L. Peckinpaugh (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 18p. Dep.; $1.00(cy), 1(mn) OTS.

An experimental bowable fuel element was developed to study temperature oscillations in the second core loading of the SRE. The bowable element featured two sets of wire spring mechanisms remotely operated during at-power reactor operation. One set bowed the five fuel rods outward to the coolant channel wall while the second set extended between the fuel rods to the channel wall. Miniature thermocouples were mounted on the springs and throughout the cluster. The spring mechanisms operated successfully during full power reactor operation in a high-temperature sodium environment. Epoxy seals for thermocouple penetrations through shield plugs were adequate; however, difficulty was experienced with core gas leakage past dynamic O-ring seals for spring actuators. Radiation streaming from straight-through gaps in shield plug penetrations for actuators and thermocouples was below permissible exposure rates. The miniature thermocouples had a 92% reliability over the one month of experimental operation. (auth)

5481 (NAA-SR-10186) AN ONLINE REACTIVITY METER FOR THE SRE. M. R. Pellet (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 18p. Dep.; $1.00(cy), 1(mn) OTS.

At the SRE, the excess reactivity is used as a continuous monitor of core normalcy during operation. To provide an immediate indication of abnormalcy, an online reactivity meter was developed. The meter consists of an analog circuit, which continuously computes the reactivity changes due to temperature, power, and xenon effects. Experience gained on the SRE Core II "meter" has proven its feasibility. Also, the data and experience gained are being used to design an operational meter for Core III. (auth)

5482 (NAA-SR-Memo-7936) SRE REACTIVITY—CALCULATION TECHNIQUE. L. M. Weaver, III (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 10, 1964. Contract AT(11-1)-Gen-8. 56p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A calculation technique designed as an analytical tool to be used for surveillance of the SRE nuclear performance is presented. A FORTRAN computer program was developed that compares the excess reactivity calculated from reactor power and temperatures to the measured reactivity obtained from the positions of the shim rods. Variations and changes in reactivity differences are investigated on the basis of changes in operating parameters. This reactivity normalcy program was successfully used for SRE core II nuclear analysis. (auth)

5483 (NP-14493) SOME PROBLEMS ASSOCIATED WITH THE CONSTRUCTION OF GRAPHITE-MODERATED, GAS-COOLED NUCLEAR POWER STATIONS. Second Edition. W. Wadkin (English Electric Co., Ltd.). Atomic Power Div., Whetstone, Leics, England). [nd]. 66p. Dep.(mn).

The planning, manufacture, erection, and inspection of Calder Hall reactors is described. Specific reference is made to the 500-Mw station at Hinkley Point; numerous illustrations of construction progress are included. (R.E.U.)

5484 (NRL-Memo-1538) NEUTRON DOSIMETRY SAMPLING OF THE OMRE PRESSURE VESSEL AND GRID PLATES. Charles Z. Serpan, Jr., and Lendell E. Steele (Naval Research Lab., Washington, D. C.). June 2, 1964. Contract AT(49-5)-2110. 23p. Dep.(mn); $0.75(cy), 1(mn) OTS.

Upon the shutdown of the organic moderated reactor experiment (OMRE), a program was initiated to determine the total neutron dosage and radiation-induced transition temperature increase to the pressure vessel and upper grid plates. Drillings were made across the grid plate and the chips were collected from each position to determine the cross-plate neutron exposure gradient. Drillings were taken and collected from the pressure vessel at the fuel centerline, upper and lower grid plate regions, and mid-way between, to determine the vertical neutron flux gradient. The results of the neutron dose analysis of these components are presented. Based upon the results, recommendations are made for testing of the material to determine the transition temperature increase. (auth)

5485 (R63CAP-71) EXPERIENCE IN FABRICATION, PRESSURE TESTING AND OPERATION OF HIGH PRESSURE HEAVY WATER SYSTEMS AT NPD. A. C. Hoyle (Canadian General Electric Co., Ltd., Peterborough, Ont.) and G. R. Howey (Ontario. Hydro-Electric Power Commission, Rolphton). Oct. 1963. 16p. (AECL-2049). Dep.; $0.50(AECL).

Specifications and procedures for the design, fabrication, installation, and commissioning of the heat transport system are described. In NPD, heavy water transfers heat from the fuel to the steam cycle. Design parameters are 1200 lb/in.^{2} and 530°F. Since there was no other reactor experience to follow, two important decisions were made: to use carbon steel for the primary piping and to fill and test with heavy water only. Full details in chronological order are given of the commissioning procedures and the precautions taken to conserve heavy water. There were 496 lb lost from leaks developing in various sites as the test pressure was raised gradually to 1850 psig. Inspection methods, cleaning procedures, deposition of a protective oxide layer in the piping, welding techniques, and degassing are detailed. Training benefits to the operating staff from participation in these procedures were apparent. (F.S.A.)

5486 (SAN-8003) PROCEEDINGS OF THE NINTH NUCLEAR SUPERHEAT MEETING, APRIL 21, 22, AND 23, 1964, SAN JOSE, CALIFORNIA. DeWitt A. Moss, ed. (San Francisco Operations Office, AEC). June 30, 1964. 228p. Dep.; $6.00(cy), 4(mn) OTS.

Separate abstracts were prepared for each of the six sessions of the conference. Included in each are separate papers pertaining to that subject. An extensive bibliography of report literature is included. (R.E.U.)

For abstracts of individual sections see: 4197, 4329, 4330, 4597, 5487, and 5488.

5487 (SAN-8003(p.1-12)) REACTOR PROJECT CONSTRUCTION AND OPERATING STATUS. (San Francisco Operations Office, AEC).

Construction and operations status are reported for Pathfinder, BORAX V, BONUS, and EVESR in separate papers. (R.E.U.)

5488 (SAN-8003(p.163-89)) PHYSICS. (San Francisco Operations Office, AEC).

Initial criticality in Pathfinder, physics studies for BORAX V, the critical assembly studies for the Mixed Spectrum Superheat Reactor, flooding effects in the superheat region of the Mixed Spectrum Critical Assembly, and criticality studies for EVESR are discussed. (R.E.U.)

5489 (TID-21292) STUDY OF OPTIMUM STEAM CONDITIONS AND CYCLES FOR LARGE SODIUM-COOLED NUCLEAR POWER PLANTS. J. A. Ford and J. J. Morabito (Atomic Power Development Associates, Inc., Detroit). Sept. 14, 1964. Contract AT(11-1)-865. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Economically optimum steam conditions and cycles were determined for large sodium-cooled nuclear power plants. The analysis encompassed the effects of steam pressure, steam temperature, reheat, and fuel cost on plant economics. The optimum steam conditions of those considered

were: steam temperature at 950°F, steam pressure at 3500 psig, and single reheat cycle. These conditions were found to be economically optimum for plants with fuel costs of both 10 and 30 cents per million Btu. Increasing the steam pressure from 1450 to 3500 psig, the range considered, gave a higher capital credit for all coresponding cases. A steam temperature of 950°F was economically more favorable than a temperature of 1050°F for most corresponding cases considered. Single reheat as opposed to no reheat was also more favorable for most cases, especially at the lower pressures. (auth)

5490 (WCAP-3269-2) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, January 1–March 31, 1964. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Contract AT(30-1)-3269. 348p. Dep.(mn); $7.00 (cy), 7(mn) OTS.

Research and development are reported in the areas of reactor physics, reactor core design and fabrication, chemical reactor shimming, reactor plant engineering, safeguards analysis, and critical experiments. (J.R.D.)

5491 THE INFLUENCE OF FLATTENING ON CERTAIN THERMAL AND PHYSICAL CHARACTERISTICS OF A CYLINDRICAL FAST REACTOR. V. V. Khromov, S. B. Shikhov, A. M. Kuz'min, and A. N. Shmelev. At. Energ. (USSR), 17: 199-201(Sept. 1964). (In Russian)

One of the possible methods of increasing the breeding ratio of a liquid-metal cooled fast reactor of high power is considered. For this method, the ratio of the height of the active zone to its diameter is changed. (tr-auth)

5492 FAST BREEDER REACTORS. P. Engelmann (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie, 9: 335-43(Sept.-Oct. 1964). (In German)

The class of fast breeder reactors is considered of special interest because it meets long-term energy requirements. Some basic considerations and a review of the present status of fast reactor development lead to a discussion of important technical, neutronic, and safety problems of this kind of reactor. The tendency toward a second generation of fast breeders is shown. A survey of the work being done at Karlsruhe in the frame of the fast breeder project is presented. (auth)

5493 EXERGETICAL INVESTIGATION OF THE COOLANT CYCLE OF TWO CYCLE NUCLEAR POWER PLANTS. Hans-Georg Paul (Lehrstuhl und Institut für Schiffsmaschinen und Dampfkessel, Hanover). Atomkernenergie, 9: 345-54(Sept.-Oct. 1964). (In German)

Using the expression "exergy" for "availability" or "utilizable part of energy") the thermodynamic process of two-cycle nuclear power plants was analyzed and the losses of exergy incurred during this process were calculated. The results of this investigation are described in degrees of energy quality and presented in diagrams. (auth)

5494 NUCLEAR ENERGY—A NEW AND GROWING MARKET. W. Finke. Atomwirtschaft, 9: 150-3(Apr. 1964). (In German)

The market arising from the use of nuclear energy is discussed, with consideration of the cost of the estimated installed nuclear power capacity in 1980, costs for different reactor types, distribution of orders in industry, and the nuclear fuel market. (D.C.W.)

5495 OPERATIONAL BEHAVIOR AND EXPERIENCE WITH THE CEGB NUCLEAR POWER STATIONS AT BERKELEY AND BRADWELL. E. Loehr (Deutsche Babcock and Wilcox-Dampfkessel-Werke AG, Oberhausen, Ger.). Atomwirtschaft, 9: 493-7(Oct. 1964). (In German)

The first two British civil nuclear power stations at Berkeley and Bradwell, each with two reactors, have been in full operation since the autumn of 1962. The generating costs of these CEGB nuclear stations amount to between 1.23 and 1.12 pence/kWh as compared with costs of 0.55 to 0.70 pence/kWh for conventional stations. The generating costs at Berkeley and Bradwell were about twice as high as had been estimated in 1955 because the interest rates at present amounted to 7.5% as against the 4% which had been assumed in making the estimates and the coal situation and efficiency of modern conventional plants has similarly changed in an unforeseen manner. The full planned capacity had not been reached by the summer of 1963 (the discussion is based essentially on the 1963 Symposium on both sets of reactors) the reduction being made necessary by a limitation on the surface temperature of the fuel element cladding. The situation will be re-examined and improved as operating experience accumulates. At Berkeley there was an excessive fall off in pressure of the superheated steam. Various modification possibilities existed for reducing this loss of pressure. The reactor cores of both stations have functioned very satisfactorily. Some minor damage to several fuel element containers was detected in good time and the cause of the fault eliminated. Changes in the fans proved to be necessary in order to avoid vibration. (auth)

5496 THE NET COST OF THE NUCLEAR KILOWATT-HOUR. Bull. Inform. Assoc. Belge Develop. Pacifique Energie At., 9: No. 51, 7-15(Aug. 1964). (In French)

The most recent data available to Euratom on the net price of the nuclear kilowatt-hour were examined at a symposium in Venice. The principal topics discussed were the method for the calculation of the net cost of nuclear energy, net cost of energy produced by nuclear power plants in the Community, net cost of the EDF and SELNI nuclear power plants, analysis of the principal construction contracts for power plants under construction, consumption and production of fissionable material in reactors, and the probable future net cost of the nuclear kilowatt-hour. The most significant data from these discussions are summarized. (J.S.R.)

5497 PROBLEMS IN DEVELOPMENT OF FAST BREEDER REACTORS. W. Schikarski (Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ingr.-Tech., 36: 819-23(Aug. 1964). (In German)

It was concluded that fast breeder reactors may provide the world's energy requirements in the distant future, since not only do they exploit more efficiently the naturally-occurring supplies of nuclear fuel but ^{238}U is converted to ^{239}Pu, an element subject to further fission. The present state of the development of these reactors, and the problems being investigated at the nuclear research center in Karlsruhe are discussed. (auth)

5498 STABILITY OF NUCLEAR CONVERTER AND SUPERHEATER ARRANGEMENTS. Robert Gibrat. Compt. Rend., 259: 2211-12(Oct. 5, 1964). (In French)

An analysis of the production of electrical energy, beginning with an ensemble of converters and superheaters, was made by introducing an equation expressing neither formation nor utilization of plutonium because all the plutonium produced is used after a certain delay for charging the superheaters. A model proposed recently at the Third Conference on the Utilization of Nuclear Energy for Peaceful Purposes seems to allow this analysis; this model takes into consideration the loss in fissile material, immobilization in the inventories, delays of retreatment, and fabrication. It is sufficiently complete. (tr-auth)

5499 ELECTRICITE DE FRANCE: THE NUCLEAR CENTERS. PRESTRESSED CONCRETE CONTAINERS OF THE REACTORS. Georges Lamiral and Jean Courbon. Energie Nucl., 6: 285-92(July-Aug. 1964). (In French)

The prestressed concrete pressure vessels of the EDF-3 and EDF-4 reactors are briefly described; and the bases and constraints for the calculations on the pressure vessels are summarized, together with associated tests on scale models. (D.C.W.)

5500 THE DRG SYSTEM OF THE EDF 2 CENTER. Paul A. Gaillard. Energie Nucl., 6: 293-304(July-Aug. 1964). (In French)

The system used for detection of can breakage in the EDF-2 reactor is described, and its operation is outlined.

A pneumatic unit circulates gas toward the detectors for analysis and obtains samples. A control board coordinates the pneumatic communications and assures data processing. (D.C.W.)

5501 IN-CORE INSTRUMENTATION AT THE HBWR. H. P. Olson (OECD Halden Reacktor Projekt, Norway). Euro Nucl., 1: 22-6(Sept. 1964).

The Halden Boiling Water Reactor (HBWR) has internationally operated for five years as an OECD Project. The program was to demonstrate the feasibility of the boiling D_2O concept and to explore the limitations of the system. The development and application of reliable in-core instrumentation during the last three years was an important part of that program, and the many new techniques that were employed are described. (auth)

5502 PRESSURE-TUBE-TYPE PRESSURIZED-WATER POWER REACTORS. G. Ackermann (VEB Atomkraftwerk, Rheinsberg, Ger.). Kernenergie, 7: 577-603(Aug. 1964). (In German)

A survey was made on pressure-tube-type pressurized water reactors, including construction, description of typical reactors, and characteristics and properties of pressure-tube power reactors. (P.C.H.)

5503 REMOTE VIEWING SYSTEM FOR "DRAGON" PROJECT. Machinery Lloyd, 36: No. 20, 31-2(Sept. 26, 1964).

A remote viewing system for the Dragon project is described. Built to meet the special conditions of viewing the interior of the reactor with a core temperature of 750°C, it comprises a combination of optical periscopes and lighting able to withstand the heat and radiation and also capable of sending back images by way of a fully transistorized image orthicon television camera placed far enough from the reactor to be protected from the temperature and radiation effects. (C.E.S.)

5504 OPERATING BIG ROCK POINT. R. L. Haueter (Consumers Power Co., Jackson, Mich.), L. M. Hausler, and R. B. DeWitt. Nucleonics, 22: No. 11, 41; 44-5 (Nov. 1964).

The significant operational experiences during the first two years of operation of the Big Rock Point Nuclear Plant are outlined. Refueling, the nuclear steam supply system, control rod drives, radiation protection systems, and the turbine-generator are discussed. (C.E.S.)

5505 PROCEEDINGS OF THE AMERICAN POWER CONFERENCE, APRIL 14, 15 and 16, 1964, CHICAGO. VOLUME XXVI. Proc. Am. Power Conf., 26: 1-1122(1964). Chicago, Illinois Inst. of Tech. $10.00. (CONF-504)

Separate abstracts were prepared for two of the sixteen papers included on nuclear power facilities. Fourteen papers were previously abstracted in NSA (18: 22522, 23052, 24878, 26829, 26949, 26950, 32209, 33115, 33116, 33753, 33822, 35121, 35184, and 35188). (D.C.W.)

For abstracts of individual papers see: 5454 and 5506.

5506 CONSIDERATIONS OF SATURATED AND SUPERHEAT STEAM CYCLES FOR BOILING-WATER REACTORS. C. E. Klotz and F. B. Daniels (Allis-Chalmers Mfg. Co., Bethesda, Md.). Proc. Am. Power Conf., 26: 168-74(1964).

The results of studies on steam cycles for boiling-water reactors are summarized. Cycles using dry and/or saturated at pressures of 1000 to 1450 psig were considered in conjunction with forced-recirculation and integral superheat reactors. Performance data for the reactors and steam cycles are summarized, together with the associated capital, fuel, and power costs. (D.C.W.)

5507 10 LET PERVOI V MIRE ATOMNOI ELEKTROSTANTSII SSSR. (The First 10 Years of the First Atomic Power Plant in USSR). Yu. I. Koryakin, ed. Moscow, Atomizdat, 1964. 216p.

Fifteen articles are included on the operation and problems of the first Russian reactor power plant. Calculations are given on overloading of research channels, isotopic composition in the fuel elements, operation of steam generators, absorptions rods, precircuit tests, and high-pressure water loop for fuel element tests. Irradiation of materials, effects of γ rays on electric conductivity of water, and contamination and purification of fuel element are discussed as well as the kinetics of reactor graphite oxidation in irradiated nitrogen medium and nitrogen and water steam mixture. (R.V.J.)

5508 LA CROSSE BOILING WATER REACTOR TANKS (Engineering Materials). (Chicago Operations Office. Reactor Engineering Div.). (CAPE-1190)

Descriptions and specifications are given of the 15 tanks used with the La Crosse Boiling Water Reactor. Fifteen drawings are included. (P.C.H.)

5509 PLANT PROTECTIVE SYSTEM FOR THE PEACH BOTTOM ATOMIC POWER STATION. John T. Bauer (General Atomic Div., General Dynamics Corp., San Diego, Calif.). New York, Instrument Society of America, 1964, Preprint 24.1-2-64, 16p. (CONF-701-2)

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

The protective system for the high-temperature, gas-cooled reactor plant is described, which primarily initiates shutdown, rapidly reduces plant power, or isolates one of the two main coolant loops. (D.C.W.)

5510 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Roger Davison Vaughan (to Nuclear Power Plant Co. Ltd. and AEI-John Thompson Nuclear Energy Co. Ltd.). British Patent 970,622. Sept. 23, 1964. Filed Feb. 28, 1962.

A gas-cooled reactor arrangement is described which offers fewer vessel sealing problems. A blower is mounted in an opening in the concrete vessel in such a way as to minimize the sealing difficulty and prevent blow back when the blower stops. A sealing ring is used in the flanged casing, and maintains the blower in position when the flange bolts fail. (T.R.H.)

5511 NUCLEAR REACTOR PLANT. Jakob Kaegi (to Gebrüder Sulzer AG). German Patent 1,173,191. July 2, 1964. Priority date, Apr. 11, 1960, Switzerland.

The reactor plant consists of two separate primary coolant circuits. A working medium is circulated through one of these two primary circuits and evaporated in a heat exchanger before entering the nuclear reactor. It performs mechanical work in a turbine after leaving the reactor. The other primary circuit contains a heat carrier, which is superheated within the reactor core and which passes through the heat exchanger to provide heat for evaporation of the water supplied by the feed pump in the primary circuit containing the working medium. The pressure within the primary circuit containing the working medium is higher than the pressure within the circuit containing the heat carrier. (Gmelin Inst.)

5512 GAS-COOLED NUCLEAR REACTOR WITH A CLOSED PRIMARY CIRCUIT. Hans Oettl, Juergen Binckenbanck, and Oskar Machnig (to Brown Boveri-Krupp Reaktorbau GmbH). German Patent 1,177,752. Sept. 10, 1964. Filed Jan. 23, 1962.

The reactor consists of a main reactor vessel containing both a core of reactive material and a first heat exchanger, e.g., a superheater heat exchanger, and a second vessel containing a second heat exchanger, e.g., a steam-generating heat exchanger. The primary coolant gas is arranged to pass around a closed circuit in which it is heated by the core and cooled by the first heat exchanger before entering the second vessel where it is further cooled by the second heat exchanger. (Gmelin Inst.)

5513 FUEL CHARGING AND DISCHARGING FOR A GAS COOLED, CERAMIC FUELLED, NUCLEAR POWER REACTOR. Winnett Boyd, John Arthur Paget, and Vernald Gilbert Lynn (to Arthur D. Little, Inc.). U. S. Patent 3,149,045. Sept. 15, 1964. Filed Aug. 4, 1959.

Improved fuel charging and discharging apparatus for a horizontally fueled, closed-circuit, gas-cooled reactor is provided by completely housing the working machinery in pressure vessels, which are permanently attached to the main reactor pressure vessel and in which the working machinery is exposed at all times to the gas pressure prevailing in the reactor pressure vessel. The apparatus consists of two charge-discharge machines, two centrally interrupted horizontal static track systems, two centrally intersecting vertical static track systems, two elevator dollies, two guide sheave dollies, gas locks and shielding gates through which the new fuel elements are inserted, spent-fuel-element discharge pepes, and a liquid expansion tank into a liquid-filled spent-fuel-element flask. (M.C.G.)

5514 NUCLEAR STEAM GENERATOR FOR A THERMO-ELECTRIC POWER PLANT. Winnett Boyd (to Arthur D. Little, Inc.). U. S. Patent 3,149,046. Sept. 15, 1964. Filed Aug. 4, 1959.

A nuclear steam generator capable of high gas temperature and requiring no thermal expansion joints in the gas ducts leading to and from the reactor is described. It consists of a gas-cooled solid-moderated nuclear reactor, a pressure vessel enclosing the reactor, at least one steam raising unit with an external pressure shell, at least one pressure duct, and at least one means of circulating the gas. (M.C.G.)

5515 NUCLEAR POWER PLANT HEAT EXCHANGER CONTROL. Anthony J. Taylor (to Babcock and Wilcox Ltd.). U. S. Patent 3,151,030. Sept. 29, 1964. Priority date Nov. 12, 1957, Great Britain.

An arrangement for minimizing temperature variation in gas coolant at the reactor inlet is offered. A value regulating gas flow in a core bypass is connected to temperature sensors at reactor inlet. Inlet temperatures are controlled by changing bypass valve opening. (T.R.H.)

5516 HIGH TEMPERATURE, SOLID MODERATED, CERAMIC FUELLED, GAS COOLED, HEAT PRODUCING NUCLEAR REACTOR. Winnett Boyd (to Arthur D. Little, Inc.). U. S. Patent 3,151,036. Sept. 29, 1964. Filed Aug. 4, 1959.

A moderator-fuel arrangement for a high-temperature gas-cooled reactor is offered. The fuel slugs of ceramic material are arranged in horizontal channels with vertical channels for coolant flow. The graphite elements which make up this core are extruded parallel to their longitudinal axes to minimize Wigner growth effects. (T.R.H.)

Process Heat Reactors

5517 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Gutehoffnungshütte Sterkrade AG). British Patent 974,166. Nov. 4, 1964. Priority date Apr. 28, 1960, Germany.

A two-zone reactor is described. The inner zone has metallic fuel with D_2O moderator. Higher temperatures and greater burnup is possible here, making it suitable for power production. The outer zone, oxide fuel with graphite moderator, could be used for space heating. (T.R.H.)

Production Reactors

5518 (HW-70618) ANALOG SIMULATION OF NPR CONFINER PRESSURE TRANSIENTS. E. D. Jones (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 2, 1961. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The confiner pressures peak twice during their excursions. The first peak occurs early in the transients, while the input disturbance, W_s, is still appreciable. The second peak, following the closing of the roof vents, occurs at the time W_s reaches zero. Since this simulation includes no outlets from the confiner vessel except the roof vents, and no provision for temperature change, the pressures will hold their peak value indefinitely; the problem ceases to be of interest after the pressures have peaked. A problem almost identical to this one was run using multipliers and high-gain amplifiers for square root circuits; these square root circuits were noisy, and their accuracy was only fair. New EASE multipliers with square root mode were used for this study. The new square root multipliers were no more noisy than conventional electronic multipliers, and quite accurate so long as the inputs did not fall below 0.1 volt. The analog simulation indicated that design pressure would not be exceeded provided the roof vents are not closed too soon after a rupture. The data indicate that the roof vents may be safely closed no earlier than 48 seconds after the occurrence of this type of rupture. (auth)

5519 A CONTINUOUS GAMMA MONITORING SYSTEM FOR DETECTING FUEL ELEMENT FAILURES IN HANFORD'S NEW PRODUCTION REACTOR. Duane O. Allred and Glenn W. Morrow (General Electric Co., Richland, Wash.). New York, Instrument Society of America, 1964, Preprint 14.1-1-64, 12p. (CONF-701-4)

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

High-pressure cooling water that has passed through the 1004 process tubes of the New Production Reactor at Hanford is sampled continuously tube by tube to detect any radioactive particles picked up from failed fuel elements. Gross gamma is detected by halogen-quenched Geiger-Mueller tubes, and gamma energy spectra are measured by scintillation detectors. Significant count rates activate an annunciator so that flow from a tube with a detected failure can be diverted rather than recirculated. The sensitivity is 10^{-8} g/ml of dissolved natural uranium, with a dose of less than 10^{11} nvt. The monitoring system is described, and its operation is outlined. (auth)

5520 SAMPLE AND CONTROL FOR FAST DETECTION OF FUEL FAILURE IN A PRESSURIZED WATER REACTOR. Roger A. Rohrbacher (General Electric Co., Richland, Wash.). New York, Instrument Society of America, 1964, Preprint 14.1-2-64, 12p. (CONF-701-3)

From Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964.

The fuel element failure monitoring system of the New Production Reactor at Hanford is described, in which samples are diverted from each of the 1004 process tube outlet connectors and are monitored continuously by Geiger-Mueller tubes and periodically by scintillation counters. (D.C.W.)

Propulsion and Space

Refer also to abstract 4302.

5521 (EUR-1888.d) RECHNUNGEN ZUR OPTIMALEN AUSLEGUNG DER PRIMARABSCHIRMUNG DES OM-SCHIFFSREAKTORS. (Shielding Calculations for the OM-Ship-Reactor). H. Wagner and H. Henssen (Internationale Atomreaktorbau G.m.b.H., Bensberg, Germany). 1964. 30p. Dep.(mn).

The methods of calculation and the results are described concerning the optimization of the primary shielding configuration for a ship reactor. The neutron fluxes are calculated according to a three energy-group diffusion theory, using group constants determined from experiments on laminated iron-water shields. The γ-dose rates at the outer edge of the shield are calculated using double exponential build-up factors. (auth)

5522 (NAA-SR-Memo-9671) MERCURY RANKINE PROGRAM (MRP) THERMOELECTRIC PUMP PERFORMANCE WITH AN INFINITE HEAT SINK. W. D. Leonard (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 18, 1964. Contract AT-11-1-GEN-8. 35p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The capabilities of the Mercury Rankine Program Thermoelectric Prototype I pump were determined for various temperature conditions. The performance equations derived previously were used as the basis for the calculations. The maximum pressure that the pump could deliver with a given set of temperature conditions was determined and from this a method was developed showing how a lighter pump could be constructed for pressures less than the maximum. The weight was reduced by using smaller magnets for magnetic fluxes less than the optimum flux. A graph showing the heat transferred as a function of the heat source and sink temperature was also prepared. Included are graphs of the various pump material properties used in the calculations. (auth)

5523 (NAA-SR-Memo-9866) STATUS REPORT OF ALUMINUM/STEEL RADIATOR CONDENSER TEST PROGRAM, R/C-10. W. P. Engle (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 30, 1964. Contract AT-11-1-GEN-8. 41p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The purpose of the test program is to verify the feasibility of the aluminum/steel R/C concept through application of various temperature and load environments to the R/C-10 structure. Low-level vibration tests, thermal performance with mercury vapor, and a two-phase static structural test were studied. (auth)

5524 (NAA-SR-Memo-9877) SNAP-10A PbSnTe T/E PUMP S/N-026 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 5, 1964. Contract AT-11-1-GEN-8. 25p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

The SNAP 10A PbSnTe T/E Pump S/N-026 was Acceptance Tested in accordance with Test Specification NA0204-005, Revision "A", and data, as obtained, are submitted with a short summary of the results. The maximum output obtained during the Pre-Reactor Startup Test was measured as 0.33 gpm of 90° NaK at a pressure of 0.006 psi, with a startup current of 40 amperes d-c. The maximum output obtained during the Orbital Full Flow Test was measured as 15.45 gpm of 1010°F NaK at a pressure of 1.093 psi. Based on the results of the above tests, T/E Pump S/N-026 meets the requirements of the test specification with regards to the "Orbital Full Flow Test" but does not meet the "Pre-Reactor Startup" requirements. (auth)

5525 (NAA-SR-Memo-10143) SNAP-10A PbSnTe T/E PUMP S/N-027 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 24, 1964. Contract AT-11-1-GEN-8. 26p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

The SNAP 10A PbSnTe T/E Pump S/N-027 was acceptance tested in accordance with Test Specification NA 0204-005, Revision "A", and data, as obtained, are submitted with a short summary of the results. The maximum output obtained during the Orbital Full Flow Test was measured as 16.44 gpm of 1010°F NaK at a pressure of 1.108 psi. The maximum output obtained during the Pre-Reactor Startup Test was measured as 0.41 gpm of 90° NaK at a pressure of 0.0059 psi, with a startup current of 40 amperes d-c. Based on the results of the above tests, T/E Pump S/N-027 meets the requirements of the Test Specification with regards to the "Orbital Full Flow Test" but does not meet the "Pre-Reactor Startup Test" requirements. (auth)

5526 (NAA-SR-Memo-10144) SNAP-10A PbSnTe T/E PUMP S/N-028 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 26, 1964. Contract AT-11-1-GEN-8. 42p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

The SNAP 10A PbSnTe T/E Pump S/N-028 was Acceptance Tested in accordance with Test Specification NA0204-005, Revision "A", and data as obtained are submitted with a short summary of the results. Special tests in addition to the Standard Acceptance Test were performed. The maximum output obtained during the Orbital Full Flow Test was measured as 15.77 gpm of 1010°F NaK at a pressure of 1.12 psi. The maximum output obtained during the Pre-Reactor Startup Test was measured as 0.33 gpm of 90° NaK at a pressure of 0.008 psi, with a startup current of 40 amperes d-c. Based on the results of the above tests, T/E Pump S/N-028 meets the requirements of the Test Specification with regards to the "Orbital Full Flow Test" but does not meet the "Pre-Reactor Startup Test" requirements. (auth)

5527 (NAA-SR-Memo-10199) SNAP-10A PbSnTe T/E PUMP S/N-022 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 14, 1964. Contract AT-1-11-GEN-8. 25p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

The SNAP 10A PbSnTe T/E Pump S/N-022 was Acceptance Tested in accordance with Test Specification NA0204-005, Revision "A", and data, as obtained, are submitted with a short summary of the results. The maximum output obtained during the Orbital Full Flow Test was measured as 15.54 gpm of 1010°F NaK at a pressure of 1.119 psi. The maximum output obtained during the Pre-Reactor Startup Test was measured as 0.36 gpm of 90° NaK at a pressure of 0.00584 psi, with a startup current of 40 amperes, d-c. Based on the results of the above tests, T/E Pump S/N-022 meets the requirements of the Test Specification with regards to the "Orbital Full Flow Test" but does not meet the "Pre-Reactor Startup" requirements. (auth)

5528 (NAA-SR-Memo-10211) EVALUATION TESTING OF HANDY AND HARMON SILFLAKE 850 FOR APPLICATION ON SNAP-10A TEMPERATURE SENSORS. A. P. Hamilton (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 13, 1964. Contract AT-11-1-GEN-8. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The application of Silflake 850 to the temperature sensors in SNAP 10A to promote better heat transfer on the resistance thermometers was studied. The thermal vacuum and vibration environment tests indicate suitability without dispersion of silver. (R.E.U.)

5529 (NAA-SR-Memo-10257) TEST REPORT ON S2PSM2 (PHASE 2) ENVIRONMENTAL TEST. H. H. Safford (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 24, 1964. Contract AT-11-1-GEN-8. 283p. Dep.(mn); $6.00(cy), 6(mn) OTS.

The object of the test program was to determine the acceleration values and/or modes of the structure and components of the SNAP unit during the following tests: mode studies, lateral decay, low level sinusoidal, 100% sinusoidal, half-sine shock, and orbital vibration. (auth)

5530 (NAA-SR-Memo-10300) SNAP-10A PbSnTe T/E PUMP S/N-029 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 14, 1964. Contract AT-11-1-GEN-8. 28p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

The SNAP 10A PbSnTe T/E Pump S/N-029 was Acceptance Tested in accordance with Test Specification NA0204-005, Revision "A," and data as obtained, is submitted with a short summary of the results. The maximum output obtained during the Orbital Full Flow Test was measured as 16.82 gpm of 1010°F NaK at a pressure of 1.138 psi. The maximum output obtained during the Pre-Reactor Startup test at a NaK Temperature of 90°F was measured as 0.44 gpm at a pressure of 0.00621 psi with a startup current of 40 amperes d-c. The Pre-Reactor Startup test was performed at four test conditions: (1) 100°F NaK, 90° sink; (2) 90°F NaK, 90°F sink; (3) 80°F NaK, 90°F sink; and (4) 80°F NaK, 70°F sink. Based on the results of the tests, the T/E pump 029 does not meet the pre-reactor startup requirements as called out in specification NA0204-005 at 90°F NaK and 90°F sink temperature. However within the tolerance specified ±10°F with the sink 10°F cooler than the

NaK, pump S/N-029 does meet the specified pre-reactor startup flows. (auth)

5531 (SC-RR-64-517) RE-ENTRY FLIGHT DEMONSTRATION NUMBER ONE (RFD-1)—ATMOSPHERIC SCIENCES SUPPORT. C. A. Coonce (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-1)-789. 25p. Dep.; $2.00(cy), 1(mn) OTS.

Data taken from the atmospheric sciences support systems for RFD-1 on May 22, 1963, at Bermuda Island, are presented. These data were taken for purposes of later analysis of the ballistic performance of the re-entry vehicle and of the heat transfer mechanisms within it, and for studies of the motion of ablated particles in the atmosphere. (auth)

5532 THE FIRST ATLANTIC CROSSING OF THE "SAVANNAH." R. Weidauer (Ingenieur fur Schiffsbetriebstechnik, Bremen). Atomwirtschaft, 9: 485-9 (Oct. 1964). (In German)

Technical observations on the first Atlantic crossing of the Savannah are described. The observations cover the reactor operation, the operation of the secondary plant, and the radiation monitoring. The reactor is controlled to have a mean primary water temperature of 462°C in the core by changing the position of 21 control rods (usually in groups), by switching in and out groups of heating rods in the pressurizer of the primary system or by injecting cold primary water into the pressure container. The rapidly responding pressure in the pressurizer serves as a control criterion. Since the Savannah reactor became critical the safety system has initiated 43 involuntary "scrams" but only once on account of a major disturbance. Reprocessing of the primary water plays an important role. From the control room it is possible not only to control and remotely monitor the reactor with its ancillary equipment but also the turbine installation. All maneuvering orders transmitted by the machine telegraph can be followed from the control point. The saturated steam turbines, the steam separator, the pneumatic control valves for diverting the steam in the condensers, the purity demands on the secondary water, as well as the various arrangements for emergency operation in the event of a defect in the reactor all represent special characteristics of the turbine plant. The total monitoring system for operation and radiation protection is very extensive. (P.C.H.)

5533 VULCAIN RESEARCH PROGRAM. P. E. Maldague (Societe Belge pour l'Industrie Nucleaire, Brussels). Euro Nucl., 1: 27-9(Sept. 1964).

Apart from the original intention of developing the Vulcain reactor as a marine propulsion unit, the present research and development program is aimed at proving the reactor in all its aspects for general industrial applications—for land-bases as well as mobile installations. The development program envisaged for the next four years is outlined. (auth)

5534 SAFETY IN NUCLEAR SHIPS. F. R. Farmer (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Joint Panel Nuclear Marine Propulsion, 8: 1-11 (Oct. 1963).

After a brief introduction to reactors and associated terminology, the main trends in reactor development toward simpler self-contained systems of reduced size are indicated. The special requirements of marine application are noted and followed by a statement of the basic conditions in heat control and balance of coolant flow essential for safety. A commentary on the function of containment and its practical limitations is followed by a more detailed review of reactor systems which have emerged in the recent search for a safe and economical system. (auth)

5535 U.S.S.R. LENIN. FOUR YEARS OF SUCCESSFUL OPERATION. Nucl. Eng., 9: 364(Oct. 1964).

The power plant of the icebreaker is briefly described; and operating experience is summarized, with particular reference to safety. (D.C.W.)

5536 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR INSTALLATIONS IN CRAFT, PARTICULARLY IN MARINE CRAFT. Alan Thomas Hooper and Louis John Sheeran (to United Kingdom Atomic Energy Authority). British Patent 975,039. Nov. 11, 1964. Filed Nov. 6, 1962.

A mounting arrangement for a reactor in a ship is described. The arrangement facilitates fueling and other servicing of the reactor. The reactor, a modular unit, is in a trunk at the bottom of the ship and can be lowered into a hole in a drydock through the trunk. The reactor exhibits some buoyancy for ease in manipulation. (T.R.H.)

5537 SHIELDING ARRANGEMENT FOR NUCLEAR-POWERED VEHICLES. Harry N. Schludi. German Patent 1,176,289. Aug. 20, 1964. Filed June 6, 1961.

A nuclear reactor located in the tail of an airplane is shielded on one side in flying in such a way that people sitting within the fuselage in front of the reactor are permanently protected from γ radiation. All other sides of the reactor are not protected while flying. Grounded the tail of the airplane is covered by a shielding arrangement shaped like a pot and mounted on wheels so that the ground personnel working in the vicinity of the airplane are also protected from the γ radiation. (Gmelin Inst.)

5538 NUCLEAR REACTOR. Donald R. MacFarlane (to U. S. Atomic Energy Commission). U. S. Patent 3,160,568. Dec. 8, 1964.

A nuclear reactor was designed for use in space. It has two hemispherical bodies of ^{233}U which are critical when adjacent, a beryllium reflector surrounding the ^{233}U bodies, a large, circular, tapered beryllium fin attached to the reflector (the reflector and the fin are split along the midplane of the fin), means associated with the fin for varying the distance between the two bodies of ^{233}U to control the reactor, and a plurality of thermoelectric elements intermediate of the reflector. (AEC)

Research and Test Reactors

5539 (CEA-R-2514) LES INSTALLATIONS CRYOGENIQUES POUR IRRADIATIONS DES REACTEURS MELUSINE ET SILOE. (The Cryogenic Installations for Irradiations in the Reactors Melusine and Siloe). Louis Bochirol, Joseph Le Calvez, Jacques Doulat, Jacques Verdier, Albert Lacaze, and Louis Weil (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). July 1964. 32p. Dep.(mn).

The study of effects created in solids by irradiation is of considerable fundamental and practical interest. Low temperature irradiation allows defects to be obtained in their simplest primary state, not being then annihilated or rearranged by thermal motion. In-pile irradiation at low temperature raises a number of technical problems connected to the necessary refrigeration power, which may be considerable; chemical processes, which may occur under irradiation; and the lack of space in a reactor. Furthermore the necessity that all the irradiation and subsequent measurements be done without reheating the samples demands continuous and reliable working of the irradiation device and its being designed so as to permit removal of the samples in the cold condition or their measurement and controlled annealing in situ. The way in which these problems were solved in Grenoble for irradiation devices at 78, 28, and 4°K in the swimming-pool reactors Melusine and Siloe is described. Some operation results are given about the liquid nitrogen rig, called Mark A, which has worked for several years in Melusine. In particular certain observations about chemical reactions which may occur in impure liquid nitrogen under radiation are made. The liquid nitrogen rig called Mark B, installed in the Siloe reactor, is described with some detail. The essential features of this apparatus are that irradiation can be performed in high fluxes, and that its operation is facilitated by a design which allows the samples to be introduced and removed without any disconnection of the apparatus. A liquid hydrogen loop, which has worked for one year in the Melusine reactor, is analyzed. An entirely closed hydrogen refrigerating circuit provides the cooling in the irradia-

tion enclosure, which contains neon. Owing to this solution, the samples may be recovered in the cold condition without hydrogen being vaporized in the atmosphere and without any pollution of the refrigerating circuit. The liquid helium loop, a prototype of which has worked, and which is being rebuilt with an increased power, is also discussed. (auth)

5540 (CEA-R-2516) QUELQUES DISPOSITIFS D'ÉTUDE DU GRAPHITE DANS LES PILES PISCINES. (Some Equipment for Graphite Research in Swimming Pool Reactors). Maurice Seguin, Philippe Arragon, Georges DuPont, Jean Gentil, and Georeges Tanis (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). July 1964. 40p. Dep.(mn).

The irradiation devices described are used for research concerning reactors of the natural uranium type, moderated by graphite, and cooled by carbon dioxide. The devices are generally designed for use in swimming pool reactors. The following points have been particularly studied: maximum use of the irradiation volume, use of the simplest technological solutions, and standardization of certain constituent parts. This standardization calls for precision machining and careful assembling; these requirements are also true when a relatively low irradiation temperature is required and the nuclear heating is pronounced. Finally, the design of these devices is suitable for the irradiation of other fissile or non-fissile materials. (auth)

5541 (IDO-16871-3) FUNDAMENTALS IN THE OPERATION OF NUCLEAR TEST REACTORS. VOLUME 3. ENGINEERING TEST REACTOR DESIGN AND OPERATION. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 1964. Contract AT(10-1)-205. 216p. Dep.; $6.00(cy), 5(mn) OTS.

The design and operation of the ETR and its associated components are discussed. Complete descriptions, including diagrams, are given for the various reactor systems. (R.E.U.)

5542 (IDO-17012) STEP PROJECT QUARTERLY TECHNICAL REPORT JULY 1963–SEPTEMBER 1963. K. A. Dietz, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 1964. Contract AT(10-1)-205. 56p. Dep.; $3.00(cy), 2(mn) OTS.

Technical achievements in the aerospace and terrestrial (engineering field tests) safety programs of the STEP project are summarized. The major effort in the aerospace program was to evaluate the performance of the SNAPTRAN 2/10A-1 test package and to bring the reactor critical. Work on the SNAPTRAN 2/10A-3 system was directed toward fabrication of experimental hardware and the installation, evaluation, and calibration of experimental instrumentation. The SNAPTRAN 2/10A-1 test package was installed in the Initial Engineering Test (IET) facility and a performance evaluation and mechanical check-out was completed. The reactor was loaded to a full core configuration, after which the control drums were calibrated and excess reactivity measurements were made. In addition, a power calibration was performed using foil activation techniques. The reactor was unloaded and removed from the IET facility to permit installation of the SNAPTRAN 2/10A-3 reactor test assembly. Work on the SNAPTRAN 2/10A-3 system for this period included electronic signal conditioning equipment evaluation and installation, pressure transducer evaluation, and nuclear detector calibration in the MTR gamma facility. The work effort on the terrestrial safety program consisted primarily of preparing the preliminary design criteria for the Loss of Fluid Tests (LOFT) reactor system and containment facilities and of performing preliminary calculations for the Nuclear Test Facility (NTF). Several fuel element designs were studied for use in LOFT and a tentative design was selected. Preliminary design of the core support structure, thermal shields, and other pressure vessel internals was completed. A study of the LOFT facility design, including the secondary coolant system, and nuclear instrumentation was made. Several proposed sites for LOFT were evaluated. Analytical studies on the LOFT system for this quarter included initiation of a transient thermal analysis of the fuel following a loss of coolant. A conceptual design for the Containment Test Facility (CTF) was completed and preliminary design work on the Nuclear Test Facility transient rod drives and core layouts was started. (auth)

5543 (JUL-146-RE) ANALYSE DENKBARER GROBSTEUERARM-UNFALLE AM REAKTOR FRJ-2. (Analysis of Conceivable Coarse Control Rod Accident in the FRJ-2 Reactor). G. Meister and K. Kalker (Kernforschungsanlage, Jülich, Germany). Apr. 1964. 49p. Dep.(mn).

A special power excursion type was investigated, which is conceivable in reactors of the DIDO type as a result of a mechanical failure in the control system of the reactor. In this type of excursion the reactor power decreases to about 20% of its initial value and then increases in the form of a steep power excursion. A method is explained by which the prospective course of the disturbance can be calculated from measured data. The uncertainty of this method is discussed. (M.C.G.)

5544 (NAA-SR-10010) SODIUM REACTOR EXPERIMENT REACTIVITY HISTORY PROGRAM. L. M. Weaver III (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 22p. Dep.; $2.00(cy), 1(mn) OTS.

A calculational technique has been developed for use as an analytical tool for surveillance of the Sodium Reactor Experiment (SRE) nuclear performance. This program specifically makes a comparison of the excess calculated reactivity and the measured reactivity determined from the positions of the calibrated shim rods. Variations and changes in reactivity differences are investigated on the basis of changes in operating parameters. The reactivity history program has been successfully used for SRE Core II nuclear analysis. (auth)

5545 (ORNL-3609) PULSE-HEIGHT SPECTRA OF GAMMA RAYS EMITTED BY THE STAINLESS-STEEL-CLAD BULK SHIELDING REACTOR II (BSR-II). G. T. Chapman, K. M. Henry, and J. D. Jarrard (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 57p. Dep.; $3.00(cy), 2(mn) OTS.

Measurements were made of the pulse-height spectra of gamma rays emitted from the core of the Bulk Shielding Reactor II (BSR-II). Preliminary analysis of the data indicates that the gamma rays having energies above 5 Mev originate primarily from thermal-neutron capture in the stainless steel reactor structure. Below 5 Mev the spectrum is apparently composed of the expected continua of prompt-fission and fission-product gamma rays plus a large contribution from thermal-neutron captures in the hydrogen of the water that moderates and reflects the core. Except for reduced intensity, little change was noticed in the structure of the distribution as the amount of water between the reactor surface and the spectrometer was increased from 1 to 60 cm. Angular-distribution measurements were also made about two points at 10 and 25 cm from the surface of the reactor. A simple calculation of the expected spectra at the surface of a homogeneous reactor compared favorably with a measured spectrum. (auth)

5546 (ORNL-TM-982) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JULY–SEPTEMBER, 1964. W. R. Casto and W. H. Tabor (Oak Ridge National Lab., Tenn.). Nov. 2, 1964. Contract [W-7405-eng-26]. 29p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Operation time improved to 87.6% because of the new shim-rod-drive tubes, the improved instrumentation, and more efficient use of shutdown time. Newly designed composite ionization chambers are now being used in a safety channel and in a log-N channel. In-service testing of a HFIR count-rate channel and heat power safety channel was started. Construction of the addition to the cell-ventilation system was completed. The collimator in HN-4 failed probably because of overheating which resulted in an increase in pressure in the aluminum cladding. (auth)

5547 MEASUREMENT OF POWER DISTRIBUTION OF THE CORE CROSS SECTION WITH A RAPID POWER INCREASE OF THE TRIGA REACTOR. H. Weiss (Osterreichische Hochschule, Vienna). Acta Phys. Austriaca, 18: 324-33(1964). (In German)

The power distribution and transient curve of the pulse of the TRIGA reactor were measured during pulsed operation by observing the Cherenkov radiation. The disadvantages and advantages of this method were indicated. The ratio of prompt to delayed fractions of the Cherenkov radiation in steady-state and pulse operation were not equivalent. However, the distribution of prompt Cherenkov radiation over the core during pulsed operation agrees with the distribution of the neutron flux. The power distributions at 100-kw, steady-state operation and in pulsed operation were determined and compared. Flattening of the distribution curve occurred in the pulsed regime. (J.S.R.)

5548 ABSOLUTE MEASUREMENT OF THE THERMAL NEUTRON FLUX IN STATIONARY- AND PULSE OPERATION OF THE TRIGA MARK II REACTOR. G. Berwanger and H. Rauch (Osterreichische Hochschule, Vienna). Acta Phys. Austriaca, 18: 334-42(1964). (In German)

The radial and vertical thermal neutron flux during steady-state operation was determined by activation of Au foils. Beta and gamma measurements agreed well within the limits of error. The thermal fraction of the activity was also determined. The radial flux distribution during pulsed operation was also measured by Au-foil activation. The time curve of the reactor approximates a Gaussian distribution very closely. The absolute flux peak was established as 1.42×10^{16} n/cm^2 sec. It is much larger than would be expected from linear extrapolation of the steady-state values. (J.S.R.)

5549 MEASUREMENT OF THE β/l RATIO IN THE TRIGA MARK II REACTOR OF THE ATOMIC INSTITUTE OF THE AUSTRIAN HOCHSCHULE, VIENNA. G. Plaschke. Acta Phys. Austriaca, 18: 343-6(1964). (In German)

The ratio between the effective component of the delayed neutrons (β) and the mean lifetime of the prompt neutrons (l) was measured using a pulsed neutron source. A value of $\beta/l = 95.4 \pm 1.5\%$ sec^{-1} was obtained. (J.S.R.)

5550 THE REBECCA REACTOR OF INDATOM. Bol. Junta Control Energia At. (Peru), 9: No. 48, 111-18(Jan.-Mar. 1964). (In Spanish)

The advantages, characteristics, installation, and uses of the REBECCA, a swimming-pool reactor with variable power between 10 and 100 kw, are summarized. (J.S.R.)

5551 THE FRJ-2 RESEARCH REACTOR (DIDO) IN JÜLICH. Klaus L. Frenkler (Kernforschungsanlage, Jülich, Ger.). Chem.-Ingr.-Tech., 36: 809-18(Aug. 1964). (In German)

The Jülich nuclear research station's FRJ-2 reactor (Dido), which has been fully operational since September 1963, is a heterogeneous reactor using fuel very rich in ^{235}U. The FRJ-2 employs heavy water for cooling and moderating the reaction. The construction of the FRJ-2 reactor and its use in scientific research are described. The safety and supervision problems involved are discussed. (auth)

5552 SUPPLEMENTARY DATA ON THE FUEL BURN-UP IN THE VVR-S–I.F.A. REACTOR BUCHAREST-RUMANIA. I. Udrea and L. Mantescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 387-91(1964).

The degree of burnup in each cluster of uranium rods in the VVR-S core was determined by a perturbation technique. (D.C.W.)

5553 THERMAL NEUTRON FLUX DISTRIBUTION IN A VVR-S FUEL ELEMENT. T. Rosescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 407-11 (1964).

The thermal neutron flux distribution in a VVR-S fuel element was calculated using the monoenergetic transport theory approximation, the P_1 spherical harmonics approximation, and semiempirical formulas. The results were compared with the elementary diffusion theory approximation. (D.C.W.)

5554 IMPROVEMENTS IN OR RELATING TO LOW TEMPERATURE IRRADIATION DEVICES. Louis Bochirol, Jacques Doulat, and Louis Weil (to Commissariat à l'Energie Atomique). British Patent 968,820. Sept. 2, 1964. Priority date July 27, 1962, France.

A cryogenic device is described for the irradiation of samples at low temperatures by the neutron flux of a swimming-pool reactor. The device is an improvement of that described in British Patent 929,585 in that a cooling fluid may be used which has a boiling point below the freezing point of the cryogenic fluid. The device comprises a fluid-tight thermally insulated container for containing a cryogenic fluid bath, a fluid-cooled heat exchanger for condensing the vapors of the cryogenic liquid, and a heating device for vaporizing the cooling fluid and heating the vapor thereof to a temperature between the boiling and freezing point of the cryogenic fluid. (D.L.C.)

5555 LOAD-LIFTING ELECTROMAGNET WITH COMPACT HOUSING, ESPECIALLY FOR MOVEMENT OF RODS IN SWIMMING POOL REACTORS. Pierre Janot and Jacky Weill (to Commissariat à l'Energie Atomique). German Patent 1,172,823. Priority date Sept. 22, 1959, France.

The lifting magnet consists of a housing of stainless steel, the bottom of which adheres to the head of the rod to be lifted, and a core, a coil, and a device for indicating the coupling between the rod and the magnet. The core and the coil are movable along the housing between two extreme positions. A spring keeps them normally in the upper position. Only when the coil is energized and the bottom of the housing is touching the rod are the core and the coil moved into the lower position. In this way a safe indication of the coupling is achieved. (Gmelin Inst.)

5556 REACTOR PILE UNIT FOR STUDYING MATERIALS UNDER RADIATION. Boris Barabach, Jacques Berger, Gérard Dupuy, Jean Lacour, and Victor Raievski (to Commissariat à l'Energie Atomique). U. S. Patent 3,147,189. Sept. 1, 1964. Priority date May 20, 1960, France.

A pile unit for a swimming-pool reactor is designed which meets requirements associated with the study of materials under radiation. The pile unit comprises a tank containing the core and having a removable cover, cooling-water inlet pipes, means for preventing the fuel elements from vibrating at rapid water circulation rates, cooling-water outlet pipes, means for preventing water leaks, screens on the tank exterior, and means for preventing the screens from vibrating. (D.L.C.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstract 4286.

5557 (HW-81091) THE CSREX PROCESS FOR CO-EXTRACTION OF CESIUM, STRONTIUM, AND RARE EARTHS— PILOT PLANT STUDIES. G. L. Richardson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 2, 1964. Contract AT(45-1)-1350. 50p. Dep.(mn); $2.00(cy), 2(mn) OTS.

The CSREX process was successfully demonstrated in pulse columns containing the same nozzle plate cartridges recommended for use with the D2EHPA process, and it was concluded that the same equipment could be used interchangeably for either process. The preferred IA column cartridge contained 23% free area stainless steel nozzle plates, the other columns contained 10% free area nozzle plates, all on two-inch spacing. Demonstrated volume velocities were over 800 gph/ft^2 for the IA and IB columns and over 500 gph/ft^2 for the IS and IC columns. Higher capacities were possible but infeasible because of low efficiency at high rates. Performance was studied in runs made at ambient temperature under near-optimum operating conditions. The feed was a tartrate-complexed Purex acid waste. A 50% reduction in flow rates had little effect on the HTU's or losses; however, a 50% rate increase nearly tripled the HTU's in the IB column and increased the IA column strontium and cerium HTU's by 30 to 70%. Strontium recovery from a synthetic Purex alkaline sludge waste was also demonstrated. The acidified sludge was first put through a lead sulfate carrier precipitation process to concentrate strontium and to remove iron and other impurities. EDTA (ethylenediaminetetraacetic acid) was then added to complex lead, and the feed was processed as before. Flowsheets and equilibrium data for both types of wastes are presented. The major limitation to the use of the CSREX process at the present time is the unusually high susceptibility of the solvent to radiation and nitrous acid degradation. Sulfamic acid and hydrazine have been successfully used in non-radioactive solutions to inhibit nitrous acid formation and solvent degradation, but their performance in preventing degradation in a radiation field has not yet been satisfactorily demonstrated. Other than loss of solvent, the major effect of degradation of pilot plant solvent appeared to be decreased efficiency of strontium and cesium stripping in the IB column. (auth)

5558 (ORNL-3627(p.73-114)) WASTE TREATMENT AND DISPOSAL. (Oak Ridge National Lab., Tenn.).

The waste treatment and disposal development program was designed to develop a comprehensive waste management system for nuclear wastes, including their final disposal, and to estimate the cost of this operation. The effective, economic management of radioactive effluents is a prerequisite to the natural growth of a nuclear power industry. Two methods are being developed for the conversion of high-level radioactive wastes (HLW) to solids, the Potcal (pot calcination) and Potglass (fixation of wastes in glassy solids) processes. The calcined or glassy solids are contained in 88-in.-long 5- to 24-in.-dia. stainless steel pipes, which are designed to be closed by welding prior to shipment and ultimate disposal. Since there are no off-gases, future surveillance requirements during ultimate disposal should be negligible. Glassy solids, rather than porous calcines, are desirable because of their higher thermal conductivity and high degree of insolubility. These properties should result in an increase in economy and safety. A major remaining program objective is to determine costs of calcination and fixation in glassy solids and the interrelation of cost and safety. Low-level radioactive wastes (LLW), such as cooling water, canal water, floor-drain water, and other very low-salt-content waters, are treated to remove radionuclides prior to their discharge to the environment. General treatment methods being developed for this purpose include the scavenging-precipitation ion-exchange process and the scavenging-precipitation foam separation process. An improved scavenging-precipitation ion-exchange process was successfully tested in a 600-gph pilot plant, where ORNL process waste was decontaminated to a level less than 2.0% of the maximum permissible levels for human exposure. The improvements reduced the estimated treatment cost from 78¢ to 66¢ per 1000 gal for a 750,000 gal/day plant. The scavenging-precipitation foam separation process will be tested in the pilot plant. These processes were developed to serve as high-capacity, bulk-treatment operations to achieve the desirable economics inherent in this type of processing, compared with the costs of specialized treatment processes where batching operations, many analyses, and high labor requirements lead to high unit costs. Intermediate-level radioactive wastes (ILW), such as residues from processing LLW, evaporator concentrates, and concentrates from the second and third solvent extraction cycles from processing nuclear fuels and other high-salt-content wastes, can be processed by incorporation in asphalt or concrete prior to burial in a controlled area. Work on incorporation in asphalt is promising (low leach rate, high volume reduction, easily shipped) and is continuing. Economic and safety analyses on the HLW management systems show that the cost of conversion of wastes to solids and their storage in ultimate disposal sites, such as a salt mine, will be well within economic limits. These studies, conducted jointly with the Health Physics Division, will be extended to other waste-solidification systems in the future to provide a sound basis for national and international comparison of alternative systems and to serve as a guide for the direction of the experimental work. (auth)

5559 (UJV-1107/64) PEREMESHCHENIE RADIOIZOTOPOV V POCHVAKH. (Migration of Radioisotopes in Soil). Z. Dlougi and I. Zaiits (Československá Akademie Věd. Ústav Jaderného Výzkumu, Řež). [1963]. 13p. Dep.(mn).

Liquid radioactive waste materials can be disposed directly in the soil only under special geological conditions, such as those prevailing at Hanford, Wash. Under the conditions prevailing in Czechoslovakia where the water table in most places is close to the surface, direct disposal is considered practically impossible. It was found however, that the lithological properties of certain quaternary deposits are favorable toward sorption; therefore, the interaction of these soils with certain long-lived isotopes was investigated. Because of their importance as contaminants of the drinking water as the result of their long half life and their similarity with the biogenic elements Ca and K, ^{90}Sr and ^{137}Cs were chosen for the study. Soil samples from Central and Northwestern Bohemia, including loess, clay, and sandy specimens were used for the tests involving the determination of their sorption capacity by chromatography. It was found that the migration of the ^{137}Cs in all the media examined is negligible. The migration of ^{90}Sr was found to depend to a great extent on the Ca content of the natural waters (or of the water used for the tests). The penetrability of the formation also was found to play an important role in this respect. It was concluded that most of the Czech soil samples have a good sorptive capacity and may be considered for the safe disposal of liquid radioactive wastes. (TTT)

5560 (UJV-1112/64) OBEZVREZHIVANIE RADIOAKTIVIYKH SBROSNYKH VOD METODOM ELEKTROKHIMICHESKOGO ANODNOTO RASTVORENIYA METALLICHESKOGO ALYUMINIYA I ZHELEZA. (Decontamination of Radioactive Liquid Waste by the Method of Electrochemical Anode Dissolution of Metallic Aluminum and Iron). I. Napravnik, Ya. Krzhizh, and M. Paar (Ceskoslovenská Akademie Věd. Ústav Jaderného Výzkumu, Řež). [1959]. 14p. Dep.(mn).

The most widely used purification processes of waste waters possessing low-level radioactivity are based on sorption and precipitation mechanisms. Previous studies revealed that the hydrated oxides of Al and Fe cannot remove the radioiodine from the waste solutions but may be employed for the precipitation of fission-product mixtures; therefore, the otherwise little-used electrochemical dissolution of Al and Fe was adapted for this purpose. Anodic dissolution of these metals yields their hydrated oxides which adsorb certain ions and then move toward one or the other electrode, depending on their charge, where they are precipitated. The efficiency of the method depends on electrolytic and electrophoretic phenomena. The potential applicability of the hydrated oxides of Zn and Cu was also examined. The method was found useful for separating various radionuclides on phosphate deposits. Comparison of the properties of the chemically precipitated oxides with those obtained by anodic dissolution revealed that the latter ones are less sensitive toward the pH of the solution and may be used in a broader range. In the tests, carried out with solutions containing 1 milliequivalent/100 ml of solution, the biologically dangerous nuclides, such as radioactive Sr, Ru, and fission product mixtures were considered. The separation factor was found to be higher in the case of the anodically prepared material. A pilot plant with a capacity able to treat 1 m^3/hr of waste liquids is under construction for the purpose of determining the effect of various factors on the separation efficiency. (TTT)

5561 RADIOACTIVE WASTE DISPOSAL. PART I. E. F. Gloyna (Univ. of Texas, Austin), S. D. Stoddard, and C. W. Christenson. Ceram. Age, 80: No. 6, 63-72(June 1964).

The rapidly growing stockpiles of high-level radioactive wastes derived from processing irradiated nuclear fuels are discussed. Descriptions of the processing techniques, problems involved in ensuring safe storage of the wastes, and some methods of converting liquid wastes to solids are included. In all, 65 references are included in Part I and 2 other parts to follow. (P.C.H.)

5562 RADIOACTIVE WASTE DISPOSAL. PART II. E. F. Gloyna (Univ. of Texas, Austin), S. D. Stoddard, and C. W. Christenson. Ceram. Age, 80: No. 7, 24-31(July 1964).

Details on ion exchange processes with montmorillonite clay, pot calcination, spray calcination, fluidized-bed calcination, and rotary-ball-kiln calcination of high level radioactive wastes are discussed. (P.C.H.)

5563 RADIOACTIVE WASTE DISPOSAL. PART III. C. W. Christenson (Los Alamos Scientific Lab., N. Mex.), Stephen D. Stoddard, Earnest F. Gloyna, Calvin C. Patterson, Warren H. Adams, and Eric B. Fowler. Ceram. Age, 80: No. 8, 31-4; 37-41(Aug. 1964). (LA-DC-6283)

A pilot plant operation that absorbs radioactive waste material in bisqued clay body and then vitrifies the body in an automated tunnel kiln is described. The preparation of a ceramic sponge is included. (P.C.H.)

5564 ON THE PURIFICATION OF RADIOACTIVE WASTE WATERS BY CONTACT PRECIPITATION. PART 2. SEMITECHNICAL-SCALE EXPERIMENTS FOR PURIFYING LABORATORY RADIOACTIVE WASTE WATERS. G. Sachse and I. Mittag (Zentralinstitut für Kernforschung, Rossendorf, Ger.). Kernenergie, 7: 614-20(Aug. 1964). (In German)

Two procedures were proved to be suitable for radioactive waste water precipitation—a single-stage process and a two-stage one. For these processes, the effects of impurities of the radiochemical waste waters as complexing agents, detergents, and others on contact precipitation were studied. By means of a preliminary semitechnical-scale plant built in the Zentralinstitut für Kernforschung Rossendorf more than 100 m^3 of waste waters produced in the institute were purified without any prejudicial affecting of the contact mass adsorptive power. For carrying out the experiments waste water of about 10^{-7} μC/ml specific activity was contaminated by fission products. Owing to the softening of waste water as a result of the contact precipitation, values of less than 1°dH of residual hardness were reached. As an experiment, further purification of the waste waters was carried out by means of ionites. (auth)

5565 CALCINER POT, 8 IN. (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1150)

This package contains 5 drawings. For a listing of individual titles see the Engineering Materials List (TID-4100). This mock-up pot is used in liquid waste calcination. It is designed for a maximum pressure of 200 psi at 600°F; a maximum temperature of 1700°F at 10 psi for 100 hr; negligible reduction of wall thickness due to corrosion during calcination; and negligible shell stresses due to contraction. Further investigation is recommended to verify design assumptions, as 304 L stainless steel is used and creep rupture data for this material were not readily available. The pot is 62.5 in. long and 8 in. ID. The reducer has an 8 in. ID at the bottom, a 4 in. ID at the top, and is 6 in. long. (F.S.)

5566 IMPROVEMENTS IN THE STORAGE TREATMENT OF RADIOACTIVE SOLUTIONS CONTAINING MOLYBDENUM. Claude Sombret (Commissariat à l'Energie Atomique). British Patent 968,763. Sept. 2, 1964. Priority date Sept. 12, 1961, France.

A process is given for treating solutions containing Mo and fission products to form a solid insoluble product. The process comprises evaporating the solution, calcining the residue to oxides, mixing the powder with the components of a phosphate glass, and heating the mixture to form the glass. Alternatively, the solution may be mixed with the components of the glass in phosphoric acid solution prior to evaporation. The process may be applied to solutions derived from the solvent extraction of irradiated Mo–U fuel elements. Several examples of the process are given. (D.L.C.)

5567 METHOD FOR THE DISPOSAL OF RADIOACTIVE WASTE MATERIALS. Guenther Friese. German Patent 1,173,998. July 16, 1964. Filed Oct. 10, 1961.

Radioactive waste can be disposed of by insertion into a waterproof container provided with protective walls of a hydraulic binding agent. The walls of the container are made of set oil shale remains. A waterproof foil is inserted into these walls and soldered or welded all over. (Gmelin Inst.)

GENERAL AND MISCELLANEOUS

5568 (IS-964) FACTORS AFFECTING THE GROWTH AND THE MECHANICAL AND PHYSICAL PROPERTIES OF BISMUTH SINGLE CRYSTALS. Robert E. Slonaker, Jr., and Morton Smutz (Ames Lab., Ames, Iowa). July 1964. Contract W-7405-eng-82. 88p. Dep.; $3.00(cy), 2(mn) OTS.

The rate of crystallization and sample purity were studied as variables in the crystallization runs. Crystal lattice orientation, crystal perfection, and the testing conditions themselves were considered as variables in some of the studies of crystal properties. Three grades of bismuth were used containing 99.99%, 99.999% and 99.9999% bismuth respectively. Two types of crystals were grown using the Bridgman procedure and a "soft mold" technique. Shaped specimens for tensile testing had a gage length of approximately 1-$\frac{1}{2}$ in. and a diameter of approximately $\frac{5}{16}$ in. for this reduced section. Tapered cylindrical specimens, with the diameter varying from $\frac{1}{2}$ in. to $\frac{5}{8}$ in. over a 3 in. length, were used for tests other than tensile tests. In both cases, the bismuth was first cast in an appropriate graphite mold and was solidified directionally from a 50° conical tip using a programmed cooling procedure. The shaped polycrystalline slug was then packed in the "soft mold" of alundum powder within a stainless steel crystallizing crucible, and the crystallizing run was executed. Also, a method was developed and is presented for growing single crystals of desired crystallographic orientation again using the Bridgman method but with a single crystal seed. This procedure was used to grow the shaped tensile specimens with primary cleavage planes oriented either parallel to or perpendicular to the growth axis. Randomly oriented single crystals were successfully produced with crystallization rates of from 0.00666 to 0.030 in./min. along the reduced section of the tensile specimens and to as high as 0.193 in./min. along the cylindrical specimens. It was apparently easier to grow single crystals as the material purity increased. Also, within these limits the critical resolved shear stress was greater and the resistivity ratio was less for crystals grown with the faster crystallization rates. No apparent correlation existed between crystallization rate and the orientation of the crystal lattice with the direction of crystal growth. Resistivity ratios between 300 and 4.2°K for the cylindrical single crystals averaged 24.4, 191, and 298 for the 4-9's, 5-9's and 6-9's bismuth, respectively. The 300°K resistivities were essentially the same for the three grades of bismuth studied with the 4.2°K resistivities reflecting the effects of impurities or imperfections. Addition of alloying elements up to a maximum of 1.0% caused both low- and high-temperature resistivities to increase, the former more rapidly than the latter. The behavior of the single crystals during tensile testing was dependent on the angle between the primary cleavage plane and the direction of load application. If the angle between the normal to this plane and the load direction was less than 70°, the crystal behaved in a ductile manner and slip was predominant; if the angle was greater than 70°, brittle behavior and twinning were predominant. The critical resolved shear stresses and critical resolved twinning stresses calculated were reasonably consistent and were sensitive to both strain rate and crystal purity. (auth)

5569 (MIT-2098-64) LABORATORY FOR NUCLEAR SCIENCE PROGRESS REPORT. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). May 1, 1964. Contract AT(30-1)-2098. 134p. Dep.(mn); $4.00 (cy), 3(mn) OTS.

Progress is reported in research on chemistry of the fission elements, nuclear chemistry, cosmic radiation, particle interactions in bubble chambers, particle physics using accelerators, physics measurements using radioisotopes, and theoretical elementary particle physics, and nuclear physics. (J.R.D.)

5570 (NYO-1480-1) NUMERICAL COMPUTATION OF HYPERSONIC FLOW PAST A TWO-DIMENSIONAL BLUNT BODY. Eva V. Swenson (New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center). Aug. 15, 1964. Contract AT(30-1)-1480. 65p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Given a two-dimensional blunt body in a steady supersonic flow of compressible fluid, the problem is to study the flow between the body and the detached shock wave formed in front of it. The shock shape is assumed to be analytic and is used as an initial line in solving a Cauchy problem for the flow and the body. Hyperbolicity of the partial differential equations of motion is achieved in the subsonic region by means of complex extension on one of the independent variables. By means of such a substitution the first order system of nonlinear equations in two dimensions is transformed into a symmetric hyperbolic system in three independent variables. Such an increase in the number of independent variables can be avoided if the equations are written in normal form with respect to two characteristic coordinates. Difference schemes of second order accuracy are derived for both formulations of the complex extension and they are programmed for the IBM 7094. Five digit accuracy is obtained in the solution and numerical results are presented for a particular flow at Mach 6. The relative merits of the two formulations are discussed. Use of the three-dimensional symmetric hyperbolic system is simple because the equations are valid in the entire domain of solution. However, stability considerations restrict the mesh ratios so that the body is barely reached. Less trouble is encountered in solving past the body when the equations in normal form are used. A serious drawback in this second approach is that the characteristics cusp at the sonic line. Thus, not only is one prevented from integrating across the sonic line, but also a portion of the flow is sometimes made inaccessible when characteristic coordinates are used. (auth)

5571 (NYO-2727-1) PROPERTIES OF ELECTROLYTES IN SOLVENT MIXTURES. Final Summary Report. Robert L. Kay (Brown Univ., Providence). Nov. 6, 1964. Contract AT(30-1)-2727. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Theories dealing with the properties of electrolytes in solvent mixtures are being tested. Results are given of conductance measurements, solvent viscosities, and the dielectric constants of $CdCl_2$ in dioxane–water mixtures. (J.R.D.)

5572 (PPAD-525-D) NUCLEAR CHEMISTRY RESEARCH AT PRINCETON UNIVERSITY, 1963–1964. Annual Progress Report. S. B. Kaufman, R. A. Naumann, and T. D. Thomas (Princeton–Pennsylvania Accelerator. Princeton, N. J.). Aug. 28, 1964. Contract AT(30-1)-2137. 48p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Irradiation of targets in the 3-Bev internal proton beam are reported along with results of proton beam distribution. Experiments to detect prompt fragments from high-energy fission were started in the internal beam. Nuclear spectroscopic studies of neutron-deficient radioisotopes produced by heavy element spallation were also initiated. Fission studies are being conducted using a ^{252}Cf source. Descriptions of new facilities and equipment are included. (J.R.D.)

5573 (SC-DC-64-1001) CORRELATION BETWEEN ELECTRICAL PULSE RESISTANCE AND MECHANICAL SHOCK RESISTANCE FOR FOUR CASTING RESINS. J. B. Allyn (Sandia Corp., Albuquerque, N. Mex.). Sept. 1964. Contract AT(29-1)-789. 13p. (CONF-769-5). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

A study was conducted to see if any correlation does

exist between electrical pulse and mechanical shock resistance in four casting resins. The study was carried out by exploding wires within four casting resins, two of them semi-rigid, and two somewhat flexible in their static behavior. The extent of fracture, the fracture rate, and evidence of exploding wire confinement were then compared to electrical pulse data. The results of the study were as follows: The two semi-rigid materials, which had very high electrical pulse resistance, had very low mechanical shock resistance. The two more flexible materials had low electrical pulse resistance but high mechanical shock resistance. The explanation of the test results is that low shock resistance is connected with rapid energy absorption. It is also connected with rapid relief of the high pressure and temperature produced in a partial breakdown filament. This rapid relief reduces charge density in the filament and perhaps thus reduces the electrical field intensity at the filament tip. Such a result would seem to promote high voltage resistance. (auth)

5574 (SC-DC-64-1002) A CONTROLLED THERMAL ENVIRONMENT FOR DIELECTRIC BREAKDOWN STRENGTH STUDIES. Lee J. Seligman (Sandia Corp., Albuquerque, N. Mex.). Sept. 1964. Contract AT(29-1)-789. 12p. (CONF-769-5). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

A small automatic temperature chamber was developed for conducting dielectric breakdown strength tests at −10 to +210°C with ±0.1°C stability. The chamber uses a pulse generator and a silicone dielectric fluid. Some results are given for an epoxy resin and three molded resins. (D.L.C.)

5575 (SC-DC-64-1003) PULSE LIFE AND DIELECTRIC STRENGTH OF A GLASS-FILLED EPOXY RESIN SYSTEM. Lee J. Seligman (Sandia Corp., Albuquerque, N. Mex.). Sept. 1964. Contract AT(29-1)-789. 6p. (CONF-769-4). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

A study was made of the possible effects of spherical glass particles (350 μin. to 0.65 in.) on the pulse life and dielectric strength of SRIR (semi-rigid inspection) epoxy resin. The cast mixtures were subjected to 10-μsec pulses at 225 to 400 kv once per second until catastrophic failure occurred. The results showed that glass fillers increased the pulse life in the long pulse life range, while the effect was small in the one-pulse breakdown threshold; this can be attributed to interruption of the treeing phenomenon by the filler particles. In some cases, where contact between filler particles occurred, the fillers hastened breakdown by presenting a more easily tracked surface. The dielectric studies showed that fillers also increase the dielectric strength. (D.L.C.)

5576 (SC-DC-64-1004) ELECTRICAL CONDUCTIVITY AS A FUNCTION OF PRESSURE IN FIVE CONJUGATED AROMATIC MONOMERS. R. G. Fitzgerald (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-1)-789. 10p. (CONF-769-3). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

The electric conductivity at 30 to 80 kb under dynamic conditions (explosively generated pressure pulses) were studied for the following compounds: fluorene, diaminofluorene, biphenyl, benzidene, and tetramethylbenzidene. It was found that pressure increases the conductivity, that fluorene and diaminofluorene attain a near-metallic state at 80 kb, and that conductivity is enhanced by high conjugation and hydrogen bonding. (D.L.C.)

5577 (SC-DC-64-1005) APPLICATION OF THE POINTED ELECTRODE IN EVALUATING PULSE LIFE OF CASTING RESINS. O. Milton (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-1)-789. 17p. (CONF-769-6). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

A simple test using a pointed electrode has been described for evaluating encapsulating resins for use in potting pulse circuits and transformers. It has been shown that conventional-type tests are likely to give misleading results if one tries to apply the data obtained to pulse applications. It has also been shown that pulse life rather than dielectric strength for a given thickness is a more meaningful test for an encapsulating resin to be used as a potting agent. (auth)

5578 (SC-R-64-180) DEVELOPMENT OF TWO PURE FLUID TIMERS. G. V. Lemmon and E. R. Phillips (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract AT-(29-1)-789. 17p. (CONF-814-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Fluid Amplification Symposium, Washington, D. C., May 1964.

The specification and subsequent development of pure-fluid timers for varying uses are reported. A prototype timer with a fluid oscillator utilizing R-C feedback is described. (R.E.U.)

5579 (SC-TM-64-1291) THE EFFECT OF DRY AND FLUID LUBRICATION ON INSTRUMENT BALL BEARING TORQUES AT HIGH SPEED. PART II. H. H. Mabie (Sandia Lab., Albuquerque, N. Mex.). Oct. 1964. Contract AT (29-1)-789. 35p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Results are presented of high-speed torque tests run on R2, R3, and R4 ball bearings lubricated with MIL-L-6085A oil and MIL-G-3278A grease. Bearings of the same sizes were also tested with PTFE retainers impregnated with MoS_2. These tests were run over a speed range of 1,000 to 40,000 rpm at room temperature with one radial load for a given bearing size. Tests were also run at a constant speed of 10,000 rpm on the grease- and oil-lubricated bearings for 60 minutes to determine the effect of time upon torque. Sample standard deviations were calculated for each data point for all of the tests. The results of the tests are presented graphically with the plus and minus value of the sample standard deviation shown for each point. (auth)

5580 (SC-TM-345-63-11) GETTING THE MOST FROM YOUR ULTRASONIC CLEANER. C. F. Schroeder, Jr., (Sandia Lab., Albuquerque, N. Mex.). Dec. 1963. Contract AT(29-1)-789. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The increased use of ultrasonic cleaners and the lack of information contained in equipment manuals indicate that some general rules are needed for the operation of ultrasonic cleaning equipment. Operating principles and their effects upon unit operation, fixture design, and parts orientation are discussed. The discussion leads to certain guides in these areas as well as some associated techniques. (auth)

5581 (SC-TM-363-63-14) SOLDERING TO THIN FILM CIRCUITRY. E. L. Chavez (Sandia Lab., Albuquerque, N. Mex.). Jan. 1964. Contract AT(29-1)-789. 11p. Dep. (mn); $1.00(cy), 1(mn) OTS.

A description is given of the soldering device and techniques used to solder component and interconnecting leads to thin-film circuitry. (auth)

5582 (SCL-DC-64-100(Vol.I)) APT TRAINING MANUAL FOR ENGINEERS. MANUAL 1. USING THE APT LANGUAGE TO DEFINE THE PART. F. E. Druss (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Nov. 1964. For Sandia Corp. Livermore Lab., Livermore, Calif. Contract AT(29-1)-789. 171p. Dep.(mn); $5.00(cy), 3(mn) OTS.

Lessons are given for the use of APT (Automatically Programmed Tools), a system for preparing instructions for numerically controlled machine tools. The lessons, which are in the form of programmed instruction, teach how to write a set of APT statements that completely defines the geometry of a part. (D.L.C.)

5583 (SCL-DC-64-100(Vol.II)) APT TRAINING MANUAL FOR ENGINEERS. MANUAL 2. VERIFYING APT PART GEOMETRY DEFINITIONS. F. E. Druss (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Nov.

1964. For Sandia Corp., Livermore, Calif. Contract AT(29-1)-789. 145p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Programmed instructions are given for teaching an APT (Automatically Programmed Tools) trainee how to make a part program for a numerically controlled drafting machine. Such a part program, when run through the computer and the drafting machine, can be used to check the APT definition statements. (D.L.C.)

5584 (SCL-DC-64-100(Vol.III)) APT TRAINING MANUAL FOR ENGINEERS. MANUAL 3. REFERENCE MATERIAL FOR MANUALS 1 AND 2. F. E. Druss (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Nov. 1964. For Sandia Corp., Livermore, Calif. Contract AT-(29-1)-789. 102p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Reference material is given for the sub-set of APT (Automatically Programmed Tools), which is needed to program a numerically controlled drafting machine. Vocabulary lists, dictionaries of major words, formats, and modifiers, and a checklist for defining part geometry are included along with answer keys for tests in Manuals 1 and 2. (D.L.C.)

5585 (SCL-TM-64-87) A COMPUTER PROGRAM FOR PREDICTING AERODYNAMIC HEATING ON SHARP CONES. Alec R. Willis (Sandia Corp. Livermore Lab., Livermore, Calif.). Nov. 1964. Contract AT(29-1)-789. 26p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Equations describing the aerodynamic heating on sharp cones and correlation functions for the properties of air are presented. The equations were programmed for solution on the IBM 1620 digital computer. The program is designed to calculate supersonic aerodynamic heating rates at several stations on the cone surface for a specified trajectory. (auth)

5586 (TID-3726) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE ISSUED OR IN PROGRESS DURING THE PERIOD OCTOBER–NOVEMBER 1964. (Division of Technical Information Extension, AEC). 24p.

A total of 90 bibliographies is listed. Report number and subject-author indexes are included. (D.L.C.)

5587 (TID-19797) SYNTHESIS OF CYTOPLASMIC HEMATIN BY NUCLEI OF ERYTHROCYTES FROM EMBRYOS. O. A. Schjeide, G. V. Alexander, J. P. OKunewick, C. R. Carmack, M. Wilkens, E. N. Carlsen, and T. G. Hennessy (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Dec. 2, 1963. Contract AT-04-1-GEN-12. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Isolated red cells from chicken embryos (youngest age group studied was 7 days of incubation) were shown to absorb as much as 20 times more ^{59}Fe during in vitro incubations than do cells from chicks and adults and synthesis as much as 30 times more hematin in a given period of time. Nearly all of the RNA in these cells is present in the nuclei. More DNA as well as RNA is present in nuclei of cells from embryos as compared with those from adults and experimental evidence, obtained by use of isotope tracers, indicates that considerable hematin synthesis takes place in the nucleus under the in vitro conditions. Much of the hematin synthesized in the nucleus is subsequently passed to the cytoplasm, probably in the form of hemoglobin. (auth)

5588 (TID-19798) RELATIONSHIPS BETWEEN HEMATIN SYNTHESIS AND MORPHOLOGICAL STRUCTURES IN ADULT AND FETAL RED CELLS. O. A. Schjeide, Ruth G. McCandless, and R. J. Munn (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Dec. 2, 1963. Contract AT-04-1-GEN-12. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Intracellular structures of nucleated red cells from chicken embryos, rabbit fetuses, chicks, and adult chickens were correlated with their capacity for iron uptake and synthesis of hematin with their content and partitioning of RNA and DNA. Electronmicrographs of sections treated with PAS stain revealed the presence of features that would permit the synthesis of hemoglobin in avian cells to take place almost exclusively in the nuclei with the hemoglobin being subsequently passed via nuclear pores to the cytoplasm. Internal structures of nucleated red cells of the rabbit fetus suggest that hemoglobin synthesis may occur both in nuclei and cytoplasms of these cells. (auth)

5589 (UCRL-11573) THE ELECTROCHEMICAL OXIDATION OF WHITE PHOSPHORUS (thesis). Michael L. Barry (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). Sept. 1964. Contract W-7405-eng-48. 155p. Dep.(mn); $5.00(cy), 3(mn) OTS.

The electrochemical oxidation of liquid and solid white phosphorus impregnated in porous conducting matrices in alkaline, neutral, and acidic electrolytes was investigated. Rates of the spontaneous disproportionation-decomposition reactions of phosphorus and the simple phosphorus oxyacids in these electrolytic solutions were also measured. Coulometric studies of the phosphorus electrode were made by comparing the rates of formation of phosphoric acid, phosphorous acid, hypophosphorous acid, phosphine, and hydrogen at known current densities to the rates of formation at zero current density. The half-cell potentials measured for the phosphorus electrodes (relative to the standard hydrogen electrode) ranged from 1.08 v in 10N NaOH to 0.00 v in 10 N H_2SO_4 compared to theoretical values of 1.83 v and 0.48 v for the oxidation of phosphorus to phosphite or phosphorus acid in these solutions. The results indicate that in alkaline media the electrode potentials were actually established by phosphine produced from the disproportionation-decomposition reactions of phosphorus. The reasons for the low electrode potentials in acidic media are not known. The coulometric studies of the anodic oxidation of phosphorus in a silver-amalgam matrix in neutral and acidic media showed that phosphorus was quantitatively oxidized to phosphorous and phosphoric acids with overall coulombic efficiencies approaching 100% at current densities up to 10 ma/cm^2. The coulometric results for the electrode in alkaline media were obscured by the effects of the simultaneous disproportionation-decomposition reactions of phosphorus. These studies indicate that the electrochemical oxidation of phosphorus could be the basis of processes with direct practical applications. (auth)

5590 (UCRL-13136) THE DETERMINATION IN SOLID PROPELLANTS. Final Technical Report, June–October 1964. R. F. Muraca (Stanford Research Inst., Menlo Park, Calif.). Oct. 1964. For California. Univ., Livermore. Lawrence Radiation Lab. Contract AT(04-3)-115. 37p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Two procedures are described for determining the water content of solid propellants containing nitrato ester oxidants. One procedure has been specifically designed for use by skilled laboratory technicians; it is predicated on the use of an efficient titration system for the Karl Fischer reagent. Water accumulation in the titration vessel from the atmosphere or other sources is minimized by the use of specially-dried helium. As a result, the water content of solid propellants requiring times greater than one hour for dispersion in solvents can be determined accurately. The other procedure embodies the use of a specially constructed manometric vessel and is based on the measurement of hydrogen pressure resulting from the reaction of calcium hydride with the water content of a solid propellant sample. Both methods are applicable for the determination of water in solid propellants containing from 0.10 to 0.01 per cent water. The role of the solvent in both determinations is discussed. (auth)

5591 (VUF-1011) SEISMIC SAFETY NET. W. V. Mickey and L. M. Lowrie (Coast and Geodetic Survey, Washington, D. C.). Aug. 1964. SHOAL Event. 75p. Dep.; $3.00(cy), 2(mn) OTS.

The seismic signal from Project SHOAL, a 12.5-kt nuclear detonation in granite near Fallon, Nevada, was recorded by the Coast and Geodetic Survey in the distance range from 0.8 km to 441 km. Thirty-nine seismograph stations participated in the Seismic Safety Program and two

technical programs, Strong-Motion Seismic Measurements and Intermediate Range Seismic Measurements. The seismic effects of the SHOAL Event in regard to the Seismic Safety Program are described and supplemental data from the two technical programs are given. Based upon an earth particle velocity of 5 cm/sec as the assumed dividing line between the safe zone and the damage zone, there were no commercial establishments or sites of habitation within the radius of possible damage for Project SHOAL. This distance was estimated at 4 km on granite and 11 km on alluvium. The radius of human perception for SHOAL, assuming a perception threshold of 0.21 cm/sec, was placed at about 45 km for alluvium foundations. This was about the distance from the event to the city of Fallon. Maximum earth particle accelerations were in agreement with the predictions for a Nevada Test Site event in granite, but transitory displacements were low by a factor of about 3. Maximum earth particle velocities satisfied the expressions: $v_{cm/sec} = 80R_{km}^{-1.9}$ (granite), and $v_{cm/sec} = 80R_{km}^{-1.15}$ (alluvium). Asymmetrical seismic wave propagation was indicated by relatively high attenuation of maximum displacements and accelerations in a direction perpendicular to the major trend of faulting in the granite of Sand Springs Range. However, attenuation of the initial P wave arrival appeared symmetrical. Calculations from strong-motion seismograms placed the source seismic energy for the SHOAL Event at 1.60×10^{18} ergs, equivalent to an earthquake of unified magnitude, m, 5.17. The "m" as determined from the Wood-Anderson seismographs was 5.22. (auth)

5592 (AEC-tr-6227/2) BULLETIN OF THE BORIS KIDRIC INSTITUTE OF NUCLEAR SCIENCES. Translation of Bilten Instituta za Nuklearne Nauke "Boris Kidric," 15: No. 2, 1964. 87p. Dep.; $1.00(cy), 2(mn) OTS.

Eight articles are included which treat the following topics: radiation damage in Mo and W, separations using zirconium pyrophosphate, heat transfer in gas flow and in finned fuel elements, neutron spectrometer work, synthesis of ^{14}C-labeled nucleotides, and orotic acid utilization for ribonucleic acid labeling in rat liver. Separate abstracts were prepared for six of the articles. (D.L.C.)

For abstracts of individual papers see: 4719, 4176, 4258, 4332, 4333, and 4486.

5593 SUPPLIES FOR NUCLEAR INSTALLATIONS—A PROFITABLE FIELD? Wolfgang D. Muller. Atomwirtschaft, 9: 153-7(Apr. 1964). (In German)

The prospects for commercial participation in the nuclear market are discussed, together with the special requirements on production and provision of processes and products for the nuclear market. (D.C.W.)

5594 RADIATION PROTECTION IN SCHOOLS. J. Pfaffelhuber. Atomwirtschaft, 9: 509-11(Oct. 1964). (In German)

Provisions of the second radiation protection regulation as applied to schools are discussed in detail. It should ensure the ample protection of both pupils and teachers. On the other hand, it should also ensure that the use of such aids in education should not be hindered by the protection measures. The regulation provides a legal basis for radiation protection in the use of radioactive materials and x-ray equipment for educational purposes. (P.C.H.)

5595 SHOULD THE PRICE ON PLUTONIUM BE FIXED? Jacques Gaussens. Bull. Inform. Sci. Tech. (Paris), No. 84, 3-16(June 1964). (In French)

Views concerning the price or value that can be attributed to plutonium are discussed. The following questions are considered: is it necessary to fix a price for plutonium?, is it desirable?, and to what extent is it possible in any case? It was concluded that a negative reply should be given to each of these questions. The idea of a price for plutonium is shown as an a posteriori idea resulting from a maximum production and not an a priori idea. The main elements of the plutonium market mechanism are described. (auth)

5596 AUSTRALIAN ATOMIC ENERGY COMMISSION TWELFTH ANNUAL REPORT, 1963–1964. (Australia Atomic Energy Commission). June 30, 1964. 80p.

An account is given of the activities of the Australian Atomic Energy Commission in the following fields: nuclear power, raw materials, high-temperature gas-cooled reactor development, reactor operations, services, radioisotopes, etc. Financial accounts and a bibliography of publications are given. (D.L.C.)

5597 DOCUMENTS ON DISARMAMENT, 1963. [Robert W. Lambert, comp.]. United States Arms Control and Disarmament Agency Publication 24. [Washington, D. C.], United States Arms Control and Disarmament Agency, 1964. 755p. $2.00(GPO).

Basic official documents regarding international developments on disarmament and related matters are included. The documents are arranged in chronological order. Bibliographic aids include lists of abbreviations, international organizations and conferences, and persons. The compilation also includes a bibliography, a topical list of documents, and an index. (P.C.H.)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is indentifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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The report number codes apply to AEC reports unless designated otherwise. Non-AEC reports are identified by parenthetical notes after the report codes; e.g., (non-AEC), (British), (Canadian), (French). The note (Misc.) identifies those codes used for both USAEC and non-AEC reports. Patents are listed under the heading "PATENTS"; the country of origin is included in parentheses.

A comprehensive listing of both AEC and non-AEC report codes is contained in TID-85(3rd Rev.), *Report Number Series Used by the Division of Technical Information in Cataloging Reports*.

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Additionally, the following countries have made their reports available as indicated.

AUSTRALIA

Australian Atomic Energy Commission Research Establishment. Available upon request from the Library, Australian Atomic Research Establishment, Private Mail Bag, Sutherland, New South Wales, Australia.

BELGIUM

Centre d'Étude de l'Énergie Nucléaire. Available upon request to individuals and organizations, from the Centre d'Étude de l'Énergie Nucléaire (CEN), 31, Rue Belliard, Bruxelles, Belgium.

CANADA

Atomic Energy of Canada Limited. For sale by the Technical Information Officer, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada. Copies are also deposited in libraries in the United Kingdom.

National Research Council of Canada. Available from the National Research Council of Canada, Ottawa 2, Ontario, Canada.

DENMARK

Atomic Energy Commission Research Establishment, Risø. Available on exchange from the Library, Danish Atomic Energy Commission, Risø, Roskilde, Denmark. Also for sale by Jul. Gjellerup, Booksellers, 87 Sölvgade, København K., Denmark.

Danatom. Available on loan from Research Establishment, Risø, Roskilde, Denmark. Copies are available from Danatom, Aurehøjvej 2, Hellerup, Denmark.

FRANCE

Commissariat à l'Énergie Atomique. Inquiries for reports numbered 1-2199 should be addressed to Commissariat à l'Énergie Atomique, Service Central de Documentation, Centre d'Études Nucléaires de Saclay, Boite Postale No. 2, Gif-sur-Yvette (S. et O.), France. Reports numbered 2200 and above are available from La Documentation Francaise, 16 Rue Lord-Byron, Paris VIII, France.

Service Central de Protection contre les Rayonnements Ionisants. Copies are available from Ministère de la Santé Publique, Service Central de Protection contre les Rayonnements Ionisants, B. P. n° 35—LE VESINET (S. et O.), France.

GERMANY

Deutsches Elektronen-Synchrotron DESY. Copies are available from Deutsches Elektronen-Synchrotron Desy, Dokumentation, 2000 Hamburg-Gr. Flottbek 1, Notkestieg 1, Germany.

Kernforschungsanlage. Copies may be ordered from Zentralbibliothek der Kernforschungsanlage Jülich, Jülich, Bundesrepublik Deutschland.

Hahn-Meitner-Institute für Kernforschung. Available without charge from Hahn-Meitner-Institute für Kernforschung Berlin, Bibliothek, Glienicker Strasse 100, 1 Berlin 39, Germany. Copies are deposited in many national nuclear centers in the world.

Johann-Wolfgang-Goethe Universität, Frankfurt Am Main, Institut für Kernphysik, (IKF). Copies are available from Gmelin Institut, 40-42 Varrentrappstrasse, Frankfurt (Main), West Germany.

ISRAEL

Israel Atomic Energy Commission. Available without charge from Ministry of Defence/Atomic Energy Commission, Soreg Research Establishment, Yavne, Israel. Copies are deposited in libraries in Israel and in other countries.

ITALY

Centro Informazioni Studi Esperienze (CISE). For sale at CISE Press Office, Casella Postale 3986, Milano, Italy. Copies are deposited in libraries in Italy.

Comitato Nazionale per l'Energia Nucleare. Copies are available from Comitato Nazionale per l'Energia Nucleare, Divisione Affari Internazionali e Studi Economici, Ufficio Pubblicazioni, Via Belisario, 15, Roma, Italy.

JAPAN

Japan Atomic Energy Research Institute (JAERI). Available from the Staff Supply Cooperative of Japan Atomic Energy Research Institute (JAERI), 1-1 Tamura-Cho, Shiba, Minato-Ku, Tokyo, Japan. Copies are deposited in depositories in Tokyo, Nagoya, and Osaka.

Nagoya University. Copies are available from Research Information Center, Institute of Plasma Physics, Nagoya University, Nagoya, Japan.

University of Tokyo. Available free of charge from Institute for Nuclear Study, University of Tokyo, Tanashi-Machi, Kitatama-gun, Tokyo, Japan.

NETHERLANDS

Reactor Centrum Nederland. For sale by Reactor Centrum Nederland, 112 Scheveningseweg, 's-Gravenhage, The Netherlands. Copies are deposited in university libraries in Holland and in many national nuclear centers in the world.

NEW ZEALAND

Institute of Nuclear Sciences. Copies are available from Librarian, Institute of Nuclear Sciences, D.S.I.R., Private Bag, Lower Hutt, New Zealand. Copies are deposited in other countries.

NORWAY

Forsvarets Forskningsinstitutt. Copies available from Norwegian Defence Research Establishment, Library, P. O. Box 25, Kjeller, Norway.

Institutt for Atomenergi. "KR" reports are available on an exchange basis from the Library, Institutt for Atomenergi, Box 40, Kjeller, Norway. Other series are not generally available to the public.

Norwegian Reactor School. Copies are available from The Library, Institutt for Atomenergi, P. O. Box 40, Kjeller, Norway.

PAKISTAN

Atomic Energy Center. Copies are available from Atomic Energy Center, P. O. Box 658, Lahore, (West Pakistan).

POLAND

Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej, (CLOR). Copies are available from Pełnomocnik Rządu d/s Wykorzystania Energii Jądrowej, Ośrodek Informacji Naukowej, Technicznej i Ekonomicznej, Warszawa, PK i N, Poland.

SPAIN

Junta de Energia Nuclear. "JEN" reports are available without charge from Servicio de Documentation, Junta de Energia Nuclear, Ciudad Universitaria, Madrid (3), Spain.

SWEDEN

Aktiebolaget Atomenergi. "AE" reports are for sale from Aktiebolaget Atomenergi, Library Section, Box 43041, Stockholm 43, Sweden. Bibliographies and literature surveys of the VDDIT- series may be obtained from Aktiebolaget Atomenergi, Information Office, Scientific and Technical Information, Box 43041, Stockholm 43, Sweden. Other series are not generally available to the public. Organizations in the atomic energy field may obtain copies from Aktiebolaget Atomenergi. Microcopy of AE reports is available from the International Documentation Centre, Tumba, Sweden.

SWITZERLAND

CERN European Organization for Nuclear Research. Available without charge from CERN European Organization for Nuclear Research, Geneva 23, Switzerland. Copies are deposited in libraries in 13 countries.

Eidgenössisches Institut für Reaktorforschung. "EIR" reports are available from Eidgenössiches Institut für Reaktorforschung, c/o Bibliothek, Würenlingen/Ag, Switzerland.

TURKEY

Turkish Atomic Energy Commission. Copies are available free of charge from T.A.E.C., Çekmece Nuclear Research Center, P. O. Box 1, Airport, Istanbul, Turkey.

UNITED KINGDOM

United Kingdom Atomic Energy Authority. Some reports are for sale in the United States by the British Information Service (BIS), 845 Third Avenue, New York, N. Y. 10022. United Kingdom reports generally may be purchased from Her Majesty's Stationery Office, London. Copies not for sale by Her Majesty's Stationery Office may be purchased in microcopy form from Micro Methods Limited, East Ardsley, Wakefield, Yorks, England. Report copies are deposited in a large number of libraries in England.

Conferences

Beginning with Volume 19, Number 1, new receipts of conference proceedings as well as individual papers from conferences will be included in this index. When a paper is received from a conference a distinctive number will be assigned to the conference in the form CONF-year-month-sequence. Individual papers will be numbered with this basic "CONF" number and in addition each will carry a further sequence number. For example, the first paper received from a conference held in January 1965 would be numbered CONF-650101-1. Conference proceeding from which no individual papers have been received will be similarly numbered with a basic number. When proceedings are abstracted the abstract will appear at the point of the basic "CONF" number for the conference. Since all information on conferences will be included in this Report Number Index the subject heading CONFERENCES will be discontinued with Volume 19, Number 1.

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EM	Blueprints and Microcopy of AEC engineering drawings are available from Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce, Springfield, Virginia 22151. Current prices of the CAPE- packages may be obtained from this address. TID-4100, available from the Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37831, contains information on all the CAPE- packages for sale.
Gmelin	Available at a nominal charge and under the AED- number shown from Atomic Energy Documentation Center, Gmelin Institute, 40-42 Varrentrappstrasse, Frankfurt (Main), West Germany.
GPO	For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.
HMSO	Her Majesty's Stationery Office, London.
IAEA	Available from the International Atomic Energy Agency.
JCL	For sale by the Special Libraries Association Translation Center, John Crerar Library, 35 West 33rd Street, Chicago, Illinois 60616.
LC	For sale by the Library of Congress, Photoduplication Service, Washington, D. C. 20540.
NAS	National Academy of Sciences, National Research Council, Washington, D. C. 20418.
NRC	For sale by the National Research Council of Canada, Ottawa, Ontario, Canada.
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UKAEA, London	Available from United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S. W. 1.
USGS	Available free of charge from the U. S. Geological Survey, Washington, D. C. 20242.

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3	19-4341	Dep.(mn); $2.00(cy), 1(mn) OTS
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420596	19-4557	$7.60(OTS)
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450228	19-4391	
450598	19-4392	
450606	19-4393	
450678	19-4100	
601083	19-3886	$2.25(OTS)
602049	19-4581	$1.00(OTS)
602159	19-4716	See NRL-Memo-1534
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606666	19-4645	See ASD-TDR-62-509(Vol.IV)
606667	19-4644	See ASD-TDR-62-509(Vol.III)
606696	19-4715	See NRL-6151
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607397	19-5267	See NRL-6125
607481	19-4649	See DMIC-205
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AECL–	**(Canadian)**	
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10-02	19-4018	Dep.(mn)
18-02	19-4770	Dep.(mn)
AERE-M–	**(British)**	
1372	19-4730	Phil. Mag. (8), 10: 723-6(1964)
AERE-R–	**(British)**	
4407	19-4726	J. Iron Steel Inst. (London), 202: 518-22 (1964)
4416	19-4673	Chem.-Ingr.-Tech., 36: 849-57(1964)
4538	19-4728	Phil. Mag. (8), 10: 579-94(1964)
AF-TDR–	**(Non-AEC)**	
64-167	19-4429	$2.00(OTS)
AGARDograph–	**(Non-AEC)**	
78	19-5081	Arctic Communications. Proceedings of the Eighth Meeting of the ARARD Ionospheric Research Committee, Athens, Greece, July 1963. Oxford, Pergamon Press, 1964. £5 Net. Distributed in the Western Hemisphere by The Macmillan Company, New York
AGN-TP–		
71	19-4654	See ORNL-3605(Vol.1)(p.3-25)
Al-Memo–	**(Misc.)**	
64-102	19-4578	Dep.(mn)
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62	19-4110	Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mf) JCL
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62-509(Vol.IV)	19-4645	$4.00(OTS)
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7527	19-4213	J. Phys. Chem., 68: 3107-15(1964)
8034	19-4055	Dep.(mn); $1.00(cy), 1(mn) OTS
8131	19-4931	Nuovo Cimento (10), 34: 795-8(1964)
8199	19-4870	Dep.(mn); $3.00(cy), 2(mn) OTS
8365	19-5165	Nucl. Phys., 62: 401-9(1965)
8448	19-5099	Phys. Letters, 13: 98-100(1964)
8528	19-4771	Dep.(mn); $2.00(cy), 1(mn) OTS
8529	19-4982	Phys. Rev. Letters, 13: 677-8(1964)
8621	19-4173	Dep.(mn); $1.00(cy), 1(mn) OTS
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CEA-R–	**(French)**	
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64-42	19-5011	Dep.(mn)
64-44	19-4451	Dep.(mn)
CISE-R–	**(Italian)**	

Report No.	Abstract No.	Availability
127	19-5403	See EURAEC-1174
CONF-151–		**(19th International Union of Pure and Applied Chemistry Congress, London)**
5	19-4096	ORINS
CONF-178–		**(European Atomic Energy Society's Symposium on Fuel Cycles for Power Reactors, Baden-Baden, Germany, Sept. 1963)**
5	19-5472	See EUR-1841.f
CONF-179–		**(American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, April 1964)**
15	19-4189	ORINS. Gmelin, AED-CONF-64-033-33
16	19-4166	ORINS. Gmelin, AED-CONF-64-033-34
CONF-274–	**19-4310**	**(3rd Annual High Temperature Liquid Metal**
	19-4318	**Heat Transfer Technology Conference, Oak Ridge, Tenn., Sept. 1963)**
CONF-303–		**(3rd International Conference on the Mössbauer Effect, Ithaca, New York, Sept. 1963)**
20	19-4769	ORINS. Gmelin, AED-CONF-63-143-21
CONF-431–	**19-4751**	**(Air Force Special Weapons Center, Albuquerque, N. Mex., Apr. 1963)**
CONF-446–		**(American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964)**
57	19-4167	ORINS. Gmelin, AED-CONF-64-081-61
62	19-4738	ORINS. Gmelin, AED-CONF-64-081-52
79	19-5113	$1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-081-47
CONF-450–		**(American Foundrymen's Society Meeting, Atlantic City, Apr. 27–May 1, 1964)**
3	19-4702	ORINS. Gmelin, AED-CONF-64-084-3
CONF-452–		**(American Physical Society, Washington, D. C., Apr. 1964)**
63	19-4229	ORINS. Gmelin, AED-CONF-64-044-82
CONF-502–		**(International Congress of Nuclear Physics, Paris, July 1964)**
22	19-5128	See JINR-D-1798
CONF-504–	**19-5505**	**(American Power Conference 26th Annual Meeting, Chicago, Apr. 1964)**
CONF-520–		**(Conference on Mass Spectrometry, Paris, Sept. 1964)**
2	19-4353	See IS-921
CONF-541–		**(International Solid State Circuits Conference, Philadelphia, Feb. 1964)**
2	19-4442	ORINS. Gmelin, AED-CONF-64-017-2
CONF-550–		**(The International Conference on High-Energy Physics, Dubna, August 5–15, 1964)**
62	19-4893	See JINR-P-1788
66	19-4891	See JINR-P-1781
67	19-4892	See JINR-P-1785
68	19-4894	See JINR-P-1789
72	19-5016	See JINR-P-1793
73	19-4895	See JINR-P-1792
CONF-555–		**(International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964)**
7	19-4394	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-083-25
CONF-556–		**(12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964)**
16	19-3985	ORINS. Gmelin, AED-CONF-64-078-17
CONF-561–	**19-4412**	**(Symposium on Inhaled Radioactive Particles and Gases, Richland, Wash., May 1964)**
CONF-571–		**(American Chemical Society 148th National Meeting, Chicago, Aug.–Sept. 1964)**
15	19-4102	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-155-12
17	19-4230	ORINS. Gmelin, AED-CONF-64-155-13
CONF-611–		**(4th International Photobiology Congress, Oxford, July 1964)**
2	19-3897	See UCRL-11668
CONF-614–	**19-4467**	**(Symposium on Crystal Diffraction of Nuclear Gamma Rays, Athens, June 1964)**
CONF-615–		**(International Conference on Lattice Defects in Quenched Metals, Argonne, Ill., June 1964)**
5	19-4648	$3.00(cy), 2(mn) OTS; Gmelin, AED-CONF-64-114-1
CONF-617–	**19-4539**	**(Special Technical Conference on Nuclear Radiation Effects, Seattle, Wash., July 1964)**
CONF-637–		**(Institute of Electrical and Electronics Engineers Region 3 Annual Meeting and Technical Conference, Clearwater, Fla., May 1964)**
7	19-4443	ORINS. Gmelin, AED-CONF-64-057-14
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8	19-3887	Dep.(mn); $2.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-082-45
16	19-4527	ORINS. Gmelin, AED-CONF-64-082-21
CONF-649–		**(12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964)**
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CONF-651–		**(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)**
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27	19-4703	ORINS. Gmelin, AED-CONF-64-140-36
30	19-4862	ORINS. Gmelin, AED-CONF-64-140-10
CONF-654–	**19-2907**	**(American Nuclear Society Meeting, San Francisco, Nov. 30–Dec. 3, 1964)**
8	19-5430	Dep.(mn); $1.00(cy), 1(mn) OTS
23	19-4614	Dep.(mn); $1.00(cy), 1(mn) OTS
CONF-701–		**(Instrument Society of America 19th Annual Instrument-Automation Conference and Exhibit, New York, Oct. 1964)**
2	19-5509	ORINS
3	19-5520	ORINS
4	19-5519	ORINS
5	19-4881	ORINS
10	19-4538	See LA-DC-6649
11	19-4276	ORINS
CONF-715–		**(13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 12–14, 1964)**
2	19-4056	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-139-6
CONF-754–		**(International Business Machines Medical Symposium, Poughkeepsie and Upton, N. Y., October 9, 1964)**
4	19-3822	See ORNL-P-722
CONF-763–		**(American Society of Mechanical Engineers Winter Meeting, New York, Nov. 29–Dec. 4, 1964)**
2	19-4270	See HW-SA-3512
CONF-765–		**(2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 3–6, 1964)**
5	19-4356	See UCRL-12125
CONF-769–		**(Conference on Electrical Insulation, Cleveland, Oct. 11–14, 1964)**
2	19-4744	See SC-DC-64-1006
3	19-5576	See SC-DC-64-1004
4	19-5575	See SC-DC-64-1003
5	19-5573	See SC-DC-64-1001
6	19-5577	See SC-DC-64-1005

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7	19-5574	See SC-DC-64-1002
CONF-773–	**(Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964)**	
4	19-4173	See BNL-8621
CONF-779–	**(Symposium on In-Core Instrumentation, Oslo, June 1964)**	
1	19-4305	See EURAEC-1109
CONF-787–	**(5th International Conference on Nuclear Photography, Geneva, Sept. 15–18, 1964)**	
1	19-4485	See UCRL-11638
CONF-789–	**(American Meteorological Society National Conference on Micrometeorology, Salt Lake City, Oct. 13–16, 1964)**	
1	19-4403	See SC-DC-64-1572
CONF-790–	**(14th Annual Analytical and Physical Testing Symposium, Cincinnati, Oct. 15–16, 1964)**	
4	19-4593	See NLCO-926
CONF-794–	**(Magnetism Conference, Minneapolis, Nov. 1964)**	
1	19-4741	See IS-1033
CONF-795–	**(International Symposium on Insulation of High Voltage in Vacuum, Cambridge, Oct. 19–21, 1964)**	
3	19-4772	See LA-DC-6539
CONF-799–	**(11th Annual Nuclear Science Symposium, Philadelphia, Oct. 28–30, 1964)**	
2	19-4775	See SLAC-PUB-57
4	19-4432	See UCRL-7952
5	19-4774	See SLAC-PUB-53
CONF-802–	**(Machine Tool Builders Conference, Hartford, Nov. 16–18, 1964)**	
1	19-4285	See Y-KE-162
CONF-803–	**(International Symposium on the Dosimetry of Irradiations from External Sources, Paris, Nov. 23–27, 1964)**	
2	19-4401	See ORNL-P-659
3	19-3821	See ORNL-P-655
CONF-804–	**(Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 15–19, 1964)**	
1	19-4740	See GA-5744
CONF-805–	**(European-American Nuclear Data Committee Meeting, Brussels, Jan. 18–22, 1965)**	
1	19-4059	See LA-DC-6723
2	19-4058	See LA-DC-6722
CONF-808–	**(American Industrial Hygiene Assoc. Rocky Mountain Section Meeting, Colorado Springs, Oct. 29–31, 1964)**	
1	19-4399	See LA-DC-6679
CONF-814–	**(Fluid Amplification Symposium, Washington, D. C., May 1964)**	
1	19-5578	See SC-R-64-180
COO–		
623-102	19-4268	Dep.(mn); $3.00(cy), 1(mn) OTS
623-104	19-5012	Dep.(mn); $4.00(cy), 3(mn) OTS
DESY–	**(German)**	
64/11	19-5388	Dep.(mn)
DLCS–		
36403	19-5470	Dep.; $6.00(cy), 3(mn) OTS
5000964	19-5471	Dep.(mn); $2.00(cy), 2(mn) OTS
DMIC–	**(Non-AEC)**	
205	19-4649	$2.00(OTS)
DMIC-Memo–	**(Non-AEC)**	
195	19-4632	$1.00(OTS)
DP–		
889	19-4633	Dep.; $2.00(cy), 1(mn) OTS
921	19-4452	Dep.; $1.00(cy), 1(mn) OTS
930	19-4240	Dep.(mn); $2.00(cy), 1(mn) OTS
DRI–	**(Misc.)**	
2189	19-4583	Dep.(mn); $3.00(cy), 2(mn) OTS
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EM–	**(Misc.)**	
3061	19-4558	See AD-421605
ETR–	**(Belgian)**	
161	19-4274	See NP-14446
EUR–	**(European Atomic Energy Community)**	
1828.d	19-4174	Dep.(mn)
1829.f	19-3888	Dep.(mn)
1835.f	19-4006	Dep.(mn)
1841.f	19-5472	Dep.(mn)
1888.d	19-5521	Dep.(mn)
1891.f	19-4825	See CEA-R-2544
1896.a	19-4584	Dep.(mn)
1913.f	19-4241	Dep.(mn)
EURAEC–		
1063	19-4713	Dep.(mn); $2.00(cy), 1(mn) OTS
1098	19-4634	Dep.(mn); $1.00(cy), 1(mn) OTS
1109	19-4305	Dep.(mn); $1.00(cy), 1(mn) OTS
1115	19-4615	Dep.(mn); $1.00(cy), 1(mn) OTS
1129(Pt.2)	19-4103	Dep.(mn); $2.00(cy), 2(mn) OTS
1159	19-4057	Dep.(mn); $2.00(cy), 1(mn) OTS
1161	19-4616	Dep.(mn); $3.00(cy), 2(mn) OTS
1174	19-5403	Dep.(mn); $1.00(cy), 1(mn) OTS
1177	19-4585	Dep.(mn); $2.00(cy), 1(mn) OTS
1190	19-4586	$3.00(cy), 2(mn) OTS
1199	19-5448	Dep.(mn); $1.00(cy), 1(mn) OTS
1246	19-5475	See GEAP-4726
1251	19-4583	See DRI-2189
1258	19-4306	See GEAP-4636
FTD-MT–	**(Non-AEC)**	
63-197	19-4334	OTS
64-271	19-4335	OTS
FTD-TT–	**(Non-AEC)**	
64-1077	19-4783	OTS
GA–	**(Misc.)**	
4622	19-5473	Dep.(mn); $2.00(cy), 1(mn) OTS
5486	19-5114	Dep.(mn); $3.00(cy), 2(mn) OTS
5744	19-4740	Dep.(mn); $1.00(cy), 1(mn) OTS
GAT–		
449	19-4352	Dep.(mn); $1.00(cy), 1(mn) OTS
GEAP–	**(Misc.)**	
4636	19-4306	Dep.(mn); $3.00(cy), 1(mn) OTS
4641	19-5474	Dep.; $3.00(cy), 2(mn) OTS
4726	19-5475	Dep.(mn); $3.00(cy), 1(mn) OTS
4739	19-4587	Dep.(mn); $2.00(cy), 1(mn) OTS
GEMP–	**(Misc.)**	
288	19-4269	Dep.(mn); $3.00(cy), 2(mn) OTS
GN–	**(Italian)**	
40	19-4307	Dep.(mc)
HW–		
31929(Rev.)	19-4192	Dep.(mn); $2.00(cy), 1(mn) OTS
64116	19-5476	$1.00(cy), 1(mn) OTS
67979	19-5449	$1.00(cy), 1(mn) OTS
70618	19-5518	Dep.(mn); $1.00(cy), 1(mn) OTS
71744	19-4395	Dep.(mn); $1.00(cy), 1(mn) OTS
77295	19-4396	Dep.(mn); $4.00(cy), 2(mn) OTS
80206	19-5477	Dep.; $3.00(cy), 2(mn) OTS
81091	19-5557	Dep.(mn); $2.00(cy), 2(mn) OTS
81334(Pt.2)	19-4714	Dep.; $4.00(cy), 3(mn) OTS
81338	19-4453	$2.00(cy), 1(mn) OTS
81486	19-4454	$1.00(cy), 1(mn) OTS

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83458	19-4430	Dep.; $1.00(cy), 1(mn) OTS
83602	19-4397	Dep.; $2.00(cy), 1(mn) OTS
83785	19-4553	Dep.; $2.00(cy), 1(mn) OTS
84101	19-4242	Dep.(mn); $1.00(cy), 1(mn) OTS
84398	19-4455	Dep.(mn); $1.00(cy), 1(mn) OTS
HW-SA-		
3335	19-4287	Health Phys., 10: 947-53(1964)
3506	19-4416	Health Phys., 10: 1129-35(1964)
3512	19-4270	Dep.(mn); $2.00(cy), 1(mn) OTS
3583	19-3878	Proc. Soc. Exptl. Biol. Med., 117: 555-8 (1964)
3597	19-3862	Health Phys., 10: 1203-9(1964)
3621	19-3866	Health Phys., 10: 1251-7(1964)
3670	19-3863	Health Phys., 10: 1211-17(1964)
IA-	**(Non-AEC)**	
897	19-4142	J. Phys. Chem. Solids, 25: 1205-12(1964)
IDO-		
12037	19-4398	Dep.; $3.00(cy), 2(mn) OTS
14645	19-4243	Dep.; $1.00(cy), 1(mn) OTS
16871-3	19-5541	Dep.; $6.00(cy), 5(mn) OTS
16985	19-5431	Dep.; $6.00(cy), 5(mn) OTS
17007	19-4232	Dep.; $2.00(cy), 1(mn) OTS
17012	19-5542	Dep.; $3.00(cy), 2(mn) OTS
17015	19-4456	Dep.; $3.00(cy), 1(mn) OTS
17024	19-4193	Dep.; $1.00(cy), 1(mn) OTS
IITRI-	**(Misc.)**	
A6040-1	19-4348	Dep.(mn); $4.00(cy), 3(mn) OTS
IMP-AEC-		
31	19-4135	J. Chem. Phys., 41: 3815-19(1964)
INSJ-	**(Japanese)**	
79	19-5127	Dep.(mn)
IS-		
816	19-4271	Dep.; $5.00(cy), 3(mn) OTS
847	19-5030	Nuovo Cimento (10), 34: 581-90(1964)
855	19-4175	Dep.; $3.00(cy), 1(mn) OTS
867	19-4650	Dep.; $2.00(cy), 2(mn) OTS
888	19-4617	Dep.; $5.00(cy), 3(mn) OTS
921	19-4353	Dep.(mn); $1.00(cy), 1(mn) OTS
942	19-4244	Dep.; $5.00(cy), 3(mn) OTS
949	19-4682	J. Chem. Phys., 41: 3799-3801(1964)
964	19-5568	Dep.; $3.00(cy), 2(mn) OTS
991	19-4279	Dep.; $3.00(cy), 2(mn) OTS
1033	19-4741	Dep.(mn); $1.00(cy), 1(mn) OTS
ISS-	**(Italian)**	
64/13	19-5013	Dep.(mn)
64/17	19-5014	Dep.(mn)
64/20	19-4457	Dep.(mn)
64/23	19-4458	Dep.(mn)
64/30	19-4459	Dep.(mn)
JAERI-	**(Japanese)**	
1062	19-4245	Dep.(mn)
JINR-	**(Russian)**	
D-1798	19-5128	Dep.(mn)
P-1777	19-5015	Dep.(mn)
P-1781	19-4891	Dep.(mn)
P-1785	19-4892	Dep.(mn)
P-1788	19-4893	Dep.(mn)
P-1789	19-4894	Dep.(mn)
P-1792	19-4895	Dep.(mn)
P-1793	19-5016	Dep.(mn)
P-1801	19-5129	Dep.(mn)
P-1816	19-4896	Dep.(mn)
P-1822	19-5017	Dep.(mn)
JuL-	**(German)**	
146-RE	19-5543	Dep.(mn)
180-PP	19-5264	Dep.(mn)
187-RX	19-4460	Dep.(mn)
190-ST	19-4354	Dep.(mn)

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JuL-Bibl-	**(German)**	
4	19-5088	Dep.(mn)
6	19-5265	Dep.(mn)
K-		
1625	19-4569	Dep.; $1.00(cy), 1(mn) OTS
KAPL-M-		
6185	19-5432	Dep.(mn); $1.00(cy), 1(mn) OTS
KFKI-	**(Hungarian)**	
15/1963	19-5130	Dep.(mn)
18/1963	19-5131	Dep.(mn)
64-1	19-5018	
LA-DC-		
6283	19-5563	Ceram. Age, 80: No. 8, 31-4; 37-41(1964)
6539	19-4772	Dep.(mn); $1.00(cy), 1(mn) OTS
6649	19-4538	$1.00(cy), 1(mn) OTS
6679	19-4399	Dep.(mn); $1.00(cy), 1(mn) OTS
6722	19-4058	Dep.(mn); $1.00(cy), 1(mn) OTS
6723	19-4059	Dep.(mn); $1.00(cy), 1(mn) OTS
LA-tr-		
64-31	19-4662	Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL
LADC-		
6081	19-4665	Acta Cryst., 17: 1382-6(1964)
6132	19-4138	J. Chem. Phys., 41: 4008(1964)
6269	19-5174	Nucl. Phys., 62: 548-60(1965)
6348	19-4755	J. Quant. Spectry. Radiative Transfer, 4: 753-60(1964)
LF-		
16	19-3820	Dep.; $3.00(cy), 2(mn) OTS
LFEN-	**(Portuguese)**	
18	19-5404	Dep.(mn)
LNF-	**(Italian)**	
64/30	19-4742	Dep.
64/37	19-4431	Dep.
64/38	19-4897	Dep.
64/39	19-4461	Dep.
64/40	19-4462	Dep.
MATT-		
224	19-5331	Phys. Fluids, 7: 1855-63(1964)
279	19-5336	Phys. Fluids, 7: 1875-7(1964)
286	19-4826	Dep.(mn); $1.00(cy), 1(mn) OTS
MCW-		
1484	19-4588	Dep.; $2.00(cy), 1(mn) OTS
MIT-	**(Misc.)**	
2098-64	19-5569	Dep.(mn); $4.00(cy), 3(mn) OTS
2098-65	19-4866	Planetary Space Sci., 12: 1055-74(1964)
2098-71	19-4976	Phys. Rev. Letters, 13: 636-9(1964)
2098-72	19-4977	Phys. Rev. Letters, 13: 640-3(1964)
2098-73	19-4973	Phys. Rev. Letters, 13: 596-8(1964)
2098-85	19-4961	Phys. Letters, 13: 188-90(1964)
MITNE-	**(Misc.)**	
33	19-5433	Dep.; $6.00(cy), 4(mn) OTS
MLM-		
1206(Tr)	19-4571	Dep.; $2.00(cy), 1(mn) OTS
1224J	19-4668	Am. Soc. Metals, Trans. Quart., 57: 916-24 (1964)
MND-	**(Misc.)**	
3062-5	19-4400	Dep.(mn); $5.00(cy), 3(mn) OTS
MND-P-		
2762	19-4871	Dep.(mn); $3.00(cy), 2(mn) OTS
2762-A	19-4567	Dep.(mn); $3.00(cy), 1(mn) OTS
MSAR-	**(Misc.)**	
61-42	19-4590	Dep.(mn); $1.00(cy), 1(mn) OTS

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61-60	19-4618	Dep.(mn); $1.00(cy), 1(mn) OTS
61-67	19-4619	Dep.(mn); $1.00(cy), 1(mn) OTS
61-100	19-4620	Dep.(mn); $1.00(cy), 1(mn) OTS
61-105	19-4591	Dep.(mn); $1.00(cy), 1(mn) OTS
61-114	19-4592	Dep.(mn); $2.00(cy), 1(mn) OTS
62-142	19-4621	Dep.(mn); $2.00(cy), 1(mn) OTS
62-159	19-4622	Dep.(mn); $2.00(cy), 1(mn) OTS
63-6	19-4623	Dep.(mn); $2.00(cy), 1(mn) OTS
63-75	19-4624	Dep.(mn); $1.00(cy), 1(mn) OTS
NAA-SR–		
4527	19-4272	Dep.; $3.00(cy), 2(mn) OTS
8474	19-5478	Dep.; $4.00(cy), 3(mn) OTS
9425	19-5394	Dep.; $3.00(cy), 2(mn) OTS
9477	19-4308	Dep.; $3.00(cy), 2(mn) OTS
9501	19-5479	Dep.; $3.00(cy), 1(mn) OTS
9733	19-4194	Dep.; $2.00(cy), 1(mn) OTS
10010	19-5544	Dep.; $2.00(cy), 1(mn) OTS
10152	19-5480	Dep.; $1.00(cy), 1(mn) OTS
10186	19-5481	Dep.; $1.00(cy), 1(mn) OTS
NAA-SR-Memo–		
7936	19-5482	Dep.(mn); $3.00(cy), 2(mn) OTS
9438	19-4289	Dep.(mn); $3.00(cy), 2(mn) OTS
9671	19-5522	$2.00(cy), 1(mn) OTS
9866	19-5523	Dep.(mn); $2.00(cy), 1(mn) OTS
9877	19-5524	Dep.(mn); $1.00(cy), 1(mn) OTS
10143	19-5525	Dep.(mn); $2.00(cy), 1(mn) OTS
10144	19-5526	Dep.(mn); $2.00(cy), 1(mn) OTS
10199	19-5527	Dep.(mn); $1.00(cy), 1(mn) OTS
10211	19-5528	Dep.(mn); $1.00(cy), 1(mn) OTS
10250	19-4273	Dep.(mn); $1.00(cy), 1(mn) OTS
10257	19-5529	Dep.(mn); $6.00(cy), 6(mn) OTS
10290	19-5395	Dep.(mn); $3.00(cy), 2(mn) OTS
10300	19-5530	Dep.(mn); $2.00(cy), 1(mn) OTS
NDA–	**(Misc.)**	
10-56(Rev.)	19-4309	
14-22	19-4625	
NLCO–		
926	19-4593	Dep.(mn); $1.00(cy), 1(mn) OTS
NMI–	**(Misc.)**	
7097-1(Del.)	19-4653	Dep.(mn); $2.00(cy), 1(mn) OTS
NOL–		
285	19-5397	See TID-21056
NP–	**(Aec File No. for Naa-AEC Reports)**	
14339	19-4773	
14356	19-4463	Dep.(mn)
14357	19-4464	Dep.(mn)
14358	19-4465	Dep.(mn)
14385	19-5266	Dep.(mn)
14433	19-4594	
14444	19-4743	
14446	19-4274	Dep.(mn); $3.00(cy), 2(mn) OTS
14469	19-4060	
14480	19-5132	Dep.(mn)
14493	19-5483	Dep.(mn)
14500	19-5133	Dep.(mn)
14501	19-5434	
14505	19-4872	Dep.(mn)
NRL–	**(Misc.)**	
6125	19-5267	$0.50(OTS)
6151	19-4715	$0.50(OTS)
NRL-Memo–	**(Misc.)**	
1534	19-4716	Dep.(mn); $0.50(cy), 1(mn) OTS
1538	19-5484	Dep.(mn); $0.75(cy), 1(mn) OTS
NRS–	**(Australian)**	
19	19-4233	Dep.(mn)
20	19-4898	Dep.(mn)
21	19-4899	Dep.(mn)
NYO–		
1480-1	19-5570	Dep.(mn); $3.00(cy), 2(mn) OTS

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1957-48	19-4180	J. Am. Chem. Soc., 86: 4741-7(1964)
1957-49	19-4181	J. Am. Chem. Soc., 86: 4747-52(1964)
2181-2	19-3889	Dep.; $3.00(cy), 3(mn) OTS
2682-1	19-4281	Dep.(mn); $6.00(cy), 4(mn) OTS
2727-1	19-5571	Dep.(mn); $1.00(cy), 1(mn) OTS
3103-1	19-3890	Dep.(mn); $1.00(cy), 1(mn) OTS
6679	19-4349	Dep.(mn); $4.00(cy), 3(mn) OTS
10211	19-5433	See MITNE-33
10626	19-4195	Dep.(mn); $1.00(cy), 1(mn) OTS
ORINS–		
47	19-4044	Dep.; $2.00(cy), 1(mn) OTS
ORNL–		
3605(Vol.1)	19-4310	Dep.; $7.00(cy), 6(mn) OTS
3605(Vol.2)	19-4318	Dep.; $7.00(cy), 6(mn) OTS
3609	19-5545	Dep.; $3.00(cy), 2(mn) OTS
3620	19-4104	Dep.; $3.00(cy), 1(mn) OTS
3627	19-4045	Dep.; $7.00(cy), 5(mn) OTS
3667	19-4106	Dep.; $2.00(cy), 1(mn) OTS
3677	19-4595	Dep.; $2.00(cy), 1(mn) OTS
3709	19-4717	Dep.; $3.00(cy), 1(mn) OTS
3710	19-4658	Dep.; $3.00(cy), 2(mn) OTS
3716	19-4900	Dep.; $5.00(cy), 3(mn) OTS
3717	19-4901	Dep.; $3.00(cy), 2(mn) OTS
3733	19-4048	Dep.; $3.00(cy), 1(mn) OTS
ORNL-P–		
10	19-3942	Nature, 204: 351-3(1964)
16	19-5334	Phys. Fluids, 7: 1873-4(1964)
92	19-3872	Nature, 204: 450-3(1964)
138	19-4210	J. Chem. Phys., 41: 4011-12(1964)
301	19-5121	Phys. Letters, 13: 234-6(1964)
329	19-5355	Phys. Rev. Letters, 13: 603-6(1964)
415	19-3854	Health Phys., 10: 1035-41(1964)
434	19-4506	Nucl. Instr. Methods, 31: 18-24(1964)
569	19-5226	Phys. Rev. Letters, 13: 668-70(1964)
655	19-3821	Dep.(mn); $2.00(cy), 2(mn) OTS
659	19-4401	Dep.(mn); $1.00(cy), 1(mn) OTS
722	19-3822	Dep.(mn); $1.00(cy), 1(mn) OTS
ORNL-TM–		
886	19-4256	Dep.(mn); $3.00(cy), 2(mn) OTS
968	19-4107	Dep.(mn); $1.00(cy), 1(mn) OTS
982	19-5546	Dep.(mn); $2.00(cy), 1(mn) OTS
1006 and Suppl.	19-4718	Dep.(mn); $1.00(cy), 1(mn) OTS
ORNL-tr–		
316	19-4111	Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mn) JCL
387	19-4559	Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mf) JCL
ORO–		
625	19-3823	Dep.; $5.00(cy), 3(mn) OTS
PAN–	**(Polish)**	
504/IX-A	19-5268	Dep.
525/VIII	19-4466	Dep.
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
965,344	19-4294	
968,212	19-5408	
968,215	19-4606	
968,216	19-5409	
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968,590	19-4608	
968,679	19-4168	
968,701	19-4169	
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968,893	19-4297	

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968,941	19-4610	
969,012	19-4611	
969,089	19-5412	
969,131	19-5457	
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